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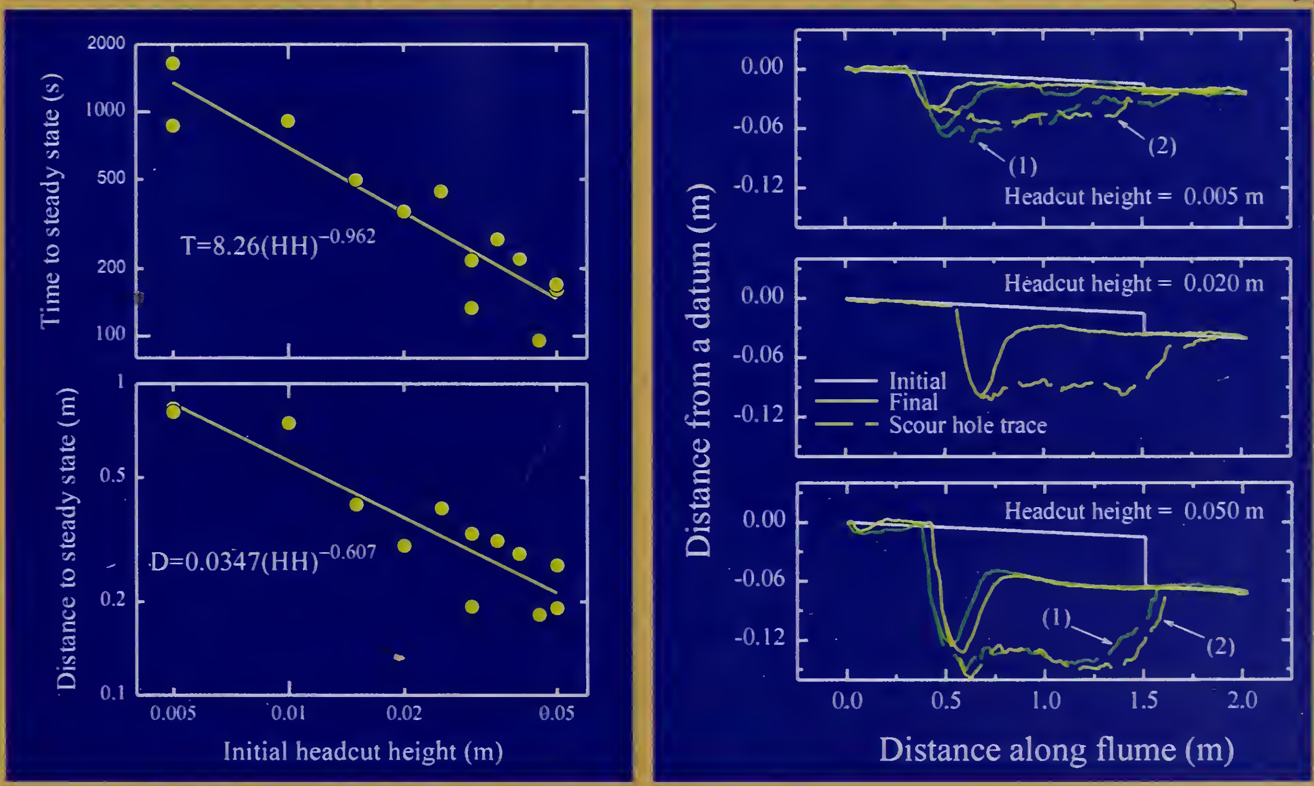
Effect of Initial Step Height on Headcut Development in Upland Concentrated Flows



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ABSTRACT

Experiments were conducted to examine the effect of initial step height on growth, development, and upstream migration of headcuts in concentrated flows typical of rills, crop furrows, and ephemeral gullies. In a laboratory channel, packed soil beds were constructed with pre-formed headcuts ranging in height from 5 to 50 mm. Each bed was subjected to the same simulated rain, which produced a protective surface seal, followed by an overland flow, which caused soil erosion exclusively at the headcut. After a brief period of bed adjustment, migration rate, scour hole geometry, and sediment yield reached asymptotic values, but the time and length required to reach these asymptotes decreased as the initial step height increased. Steady-state headcut dimensions, sediment yield, and the slope of the sediment deposit increased as initial step height increased, but sediment sorting patterns downstream of the migrating headcut remained unchanged.

ACKNOWLEDGEMENTS

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1 INTRODUCTION

Intense, localized erosion of soil, sediment, and bedrock often occurs at discrete step-changes in the bed elevation on hillslopes and within streams and rivers, and these steps are referred to as headcuts and knickpoints [*Brush and Wolman*, 1960; *Holland and Pickup*, 1976; *Gardner*, 1983; *Schumm et al.*, 1984, 1987]. The formation of headcuts and knickpoints and their upstream migration have been linked to erosion in rills, crop furrows, ephemeral gullies, and classic gullies, concentration of overland flow, initiation of drainage systems, erosion of bedrock channels, and landscape evolution [see review and references in *Bennett et al.*, 2000]. In upland areas, erosion due to headcut migration can significantly increase soil loss and adversely affect farm productivity [*Mosley*, 1974; *Meyer et al.*, 1975; *Bryan*, 1990; *Römkens et al.*, 1996, 1997].

An experimental research program was initiated to examine the characteristics of actively migrating headcuts in soil materials typical of upland concentrated flows. Motivation for this work was the construction of a database to be used in the analytical formulation of soil erosion prediction technology that specifically addresses headcut erosion in agricultural areas. Results from this program have described systematic behavior of headcut growth and development previously unreported. For a given initial headcut height and bed slope, *Bennett et al.* [2000] observed (1) steady-state erosion conditions where headcut geometry, rate of migration, and sediment yield remained unchanged as the headcut moved upstream, and (2) scour hole dimensions became progressively larger in response to an increase in overland flow discharge but geometry was conserved. For a given initial headcut height and overland flow discharge, *Bennett*

[1999] observed (1) an increase in scour hole dimensions with an increase in bed slope, (2) steady-state erosion conditions for migrating headcuts with submerged (nonventilated) overfall nappes on bed slopes 2% and smaller, (3) non-steady state erosion conditions for migrating headcuts with ventilated overfall nappes on bed slopes 3% and greater, and (4) the conservation of headcut geometry over the entire range of bed slopes examined.

Limited research on headcut development suggests that the depth of scour depends on (1) upstream boundary conditions such as flow discharge, velocity, and depth; (2) the characteristics of the overfall such as the thickness and velocity of the jet upon entry into the plunge pool, jet entry angle, and jet diffusion coefficient; (3) material characteristics such as the sediment's critical tractive shear stress and erodibility coefficient; and (4) downstream boundary conditions, usually tailwater or backwater height [*Stein et al.*, 1993]. It is generally accepted that plunge-pool erosion in a headcut scour hole is considered dynamically similar to impinging jets, drop spillways, and pipe outlets [*Donnelly and Blaisdell*, 1965; *Rajaratnam*, 1981; *Blaisdell and Anderson*, 1988; *Bormann and Julien*, 1991].

In the companion studies of *Bennett et al.* [2000] and *Bennett* [1999], the erosivity of the overland flow, hence the erosive potential of the impinging jet, was varied either by increasing the discharge for a given bed slope or by increasing the bed slope for a given discharge, but in each case the initial headcut height was 25 mm. Assuming that upstream boundary conditions can be replicated, does the initial step height or bed discontinuity have an effect on the asymptotic steady-state scour hole dimensions? To address this question, the present study sought to extend this experimental methodology

by examining for a given bed slope and overland flow discharge the effect of initial step height on headcut growth and development, steady-state scour hole dimensions, migration rate, and sediment yield. Error analysis of the data, repeatability of experiments, a quantitative definition of steady-state erosion, and sediment sorting processes associated with headcut erosion are also discussed.

2 EXPERIMENTAL EQUIPMENT AND PROCEDURE

The design and description of the experimental facility and the procedure for preparing the soil bed, applying the rainfall, and monitoring runoff and headcut erosion processes are described in detail by *Bennett et al.* [2000] and *Bennett* [1999]. These utilities are briefly described herein. A summary of all experimental parameters is given in Table 1.

2.1 Bed Preparation and Rainfall Application

All experiments were conducted in a non-recirculating, 5.5-m long tilting flume. Water was fed initially into an inlet tank 0.8 m long, 0.4 m wide, and 0.3 m deep. Once filled, water spilled onto a raised floor, 1 m long and 0.165 m wide, located immediately upstream of a soil cavity 2 m long, 0.165 m wide, and 0.25 m deep. A subsurface drainage system was placed along the base of the soil cavity, allowing the escape of air and water during rainfall application.

The material used in this study is a sandy loam to sandy clay loam texture (Ruston Series; fine-loamy, siliceous, thermic, Typic Paleudult; *Römkens et al.*, 1997), commonly found in the southeastern U.S. The soil material was air dried, mechanically crushed, and passed through a 2-mm sieve. It was packed incrementally into the flume in layers of

Table 1. Summary of experimental characteristics. Each column refers to an individual experimental runs, and steady-state parameters represent time or spatially averaged values.

Parameter	Units	Experimental Run												
Initial Experimental Parameters														
Initial headcut height	mm	5(1)	5(2)	10	15	20	25	30(1)	30(2)	35	40	45	50(1)	50(2)
Soil bulk density	Mg m^{-3}	1.557	1.679	1.621	1.526	1.533	1.519	1.486	1.602	1.545	1.514	1.537	1.557	1.562
Rainfall rate	mm h^{-1}	26.7	26.7	26.7	26.7	26.7	21.2	21.2	26.7	21.2	26.7	26.7	26.7	26.7
Rainfall duration	h	4.60	4.60	4.60	4.60	4.60	4.57	4.62	4.60	4.55	4.60	4.60	4.60	4.60
Total rainfall	mm	122.9	122.9	122.9	122.9	122.9	96.9	97.9	122.9	96.5	122.9	122.9	122.9	122.9
Bed slope during rainfall	%	5	5	5	5	5	5	5	5	5	5	5	5	5
Time of runoff initiation	h	1.57	1.18	1.08	1.32	1.08	1.37	1.18	1.33	0.85	1.00	1.03	0.93	1.33
Runoff rate at conclusion	mm h^{-1}	18.9	19.8	21.3	21.2	22.5	18.4	17.0	22.1	19.5	20.5	21.4	21.2	19.8
Bed slope during overland flow	%	1	1	1	1	1	1	1	1	1	1	1	1	1
Overland flow run time	s	2130	1230	1065	1035	1110	915	730	660	885	840	660	810	1080
Flow discharge	l min^{-1}	69.6	70.8	69.5	69.8	70.0	69.9	70.1	69.3	69.8	70.2	69.9	69.9	69.9
Upstream flow depth	m	0.014	0.014	0.014	0.013	0.014	0.014	0.016	0.014	0.015	0.014	0.014	0.014	0.014
Upstream flow velocity	m s^{-1}	0.521	0.519	0.501	0.530	0.521	0.496	0.440	0.509	0.479	0.508	0.516	0.506	0.523
Steady-state Parameters														
Headcut migration rate	mm s^{-1}	0.648	1.030	0.886	0.959	0.833	1.090	1.424	1.527	1.051	1.135	1.546	1.225	0.94
Maximum scour depth (S_D)	m	0.054	0.053	0.067	0.072	0.081	0.094	0.094	0.089	0.106	0.108	0.103	0.125	0.132
Length to S_D (S_L)	m	0.093	0.099	0.110	0.085	0.087	0.070	0.078	0.087	0.070	0.090	0.083	0.087	0.081
S_L/S_D		1.725	1.898	1.640	1.187	1.073	0.753	0.838	0.987	0.664	0.830	0.805	0.698	0.606
$\tan^{-1}(S_D/S_L)$	degrees	30.3	28.5	29.9	40.2	43.2	53.1	50.3	45.5	56.5	50.4	51.2	55.1	58.9
Water depth at S_D (T_W)	m	0.062	0.061	0.062	0.073	0.080	0.091	0.091	0.074	0.099	0.096	0.084	0.103	0.100
T_W/S_D		1.15	1.15	0.93	1.01	0.99	0.97	0.97	0.83	0.93	0.89	0.82	0.82	0.76
Jet entry angle	degrees	30.3	32.1	41.6	45.0	45.3	52.1	50.1	61.6	62.2	62.2	68.8	75.5	72.5
Time of overfall ventilation	s	s.j.	s.j.	s.j.	s.j.	s.j.	s.j.	s.j.	126	86	93	53	4	6
Sediment yield (S_Y)	kg s^{-1}	0.0058	0.0071	0.0081	0.0103	0.0090	0.0151	0.0183	0.0214	0.0159	0.0199	0.0239	0.0270	0.0222
Deposit thickness	m	0.042	0.038	0.047	0.049	0.061	0.067	0.074	0.053	0.083	0.070	0.062	0.079	0.081
Deposit bulk density	Mg m^{-3}	1.405	1.480	1.468	1.456	1.423	n.a.	n.a.	1.396	n.a.	1.451	1.516	1.456	1.393
Slope of self-made bed	%	n.a.	0.16	0.60	1.31	1.94	1.07	1.47	1.49	2.75	2.23	4.52	2.35	4.22
Time to steady state (S_D)	s	1650	870	914	496	360	444	134	218	270	220	96	161	170
Distance to steady state (S_D)	m	0.834	0.812	0.749	0.411	0.303	0.400	0.193	0.332	0.314	0.285	0.182	0.262	0.192
Time to steady state (S_Y)	s	n.a.	n.a.	376	347	429	312	234	220	365	250	242	255	294
Distance to steady state (S_Y)	m	n.a.	n.a.	0.312	0.264	0.358	0.364	0.354	0.335	0.428	0.326	0.435	0.379	0.317

s.j.: submerged jet, overfall never became ventilated; n.a.: not available

about 20 mm and tamped in a uniform and systematic manner. Soil bulk density ranged from 1.486 to 1.680 Mg m^{-3}, with a mean density of 1.557 Mg m^{-3} (Table 1).

After packing the soil to a pre-described depth, an aluminum frame was placed 1.52 m downstream of the soil cavity's entrance for the purpose of forming a headcut. Since this study focused on the effect of initial step height on headcut development, 10 different heights were used: 5, 10, 15, 20, 25, 30, 35, 40, 45, and 50 mm. In addition, experiments using the 5, 30, and 50-mm step heights were replicated (designated, for example, 5(1) and 5(2), Table 1). After installation, soil was packed upstream of the frame producing a pre-formed vertical step in the bed profile.

The soil material within the uppermost 20 mm of the packed bed was treated with 0.75 cmol of $Ca(OH)_2$ per 100 g of soil (about 0.74 g per 1 kg of soil) to promote a physio-chemically favorable condition for seal development [*Römkens, Gerits, and Prasad, unpubl. ms.*; *Bennett et al.*, 2000]. Following the application of simulated rain, a well-developed and reproducible surface seal formed. During overland flow, the seal prevented surface soil detachment both upstream and downstream of the headcut. Moreover, the seal produced the requisite two-layer stratigraphy common to many stepped headcuts and knickpoints [e.g. *Holland and Pickup*, 1976; *Bryan and Poesen*, 1989].

Suspended approximately 4 m above the flume was a multiple-intensity rainfall simulator consisting of two oscillating nozzles spaced 1.64 m apart [see *Meyer and Harmon*, 1979; *Bennett et al.* 2000]. Simulated rain was applied at rates of either 26.7 mm h^{-1} (10 experiments) or 21.2 mm h^{-1} (3 experiments) for 4.6 h to a bed slope of 5% (Table 1; this slope ensured the rainfall would not create ponded water). Due to a

calibration error, a lower rainfall rate was used in three of the experiments. Through the flume's sidewall, advance of the wetting front was recorded to videotape. During rainfall application, inception of surface runoff was noted, and rate of runoff was obtained (Table 1). Surface runoff occurred after 1.2 h of rainfall, and after 3 h runoff rates attained values of about 80% of the applied rate.

2.2. Overland Flow, Data Acquisition, and Error Analysis

With the rainfall application completed, the headcut-forming plate was removed from the flume, the bed slope was adjusted to 1%, and an overland flow of known discharge was released onto the soil material. The overland flow discharge was about 69.9 l min^{-1}, mean upstream flow depth was about 14 mm, and mean upstream flow velocity was about 0.57 m s^{-1} (Table 1). Flow discharge was controlled by two adjustable intake valves and monitored with a manometer and a pressure transducer connected to an inline Venturi meter. All water and sediment that passed through the flume was concentrated into an outlet pipe where sampling took place.

A video camera mounted to a movable carriage recorded the growth and development of the headcut in each experiment. From these images, the following information could be determined: position and morphology of the headcut, overland flow depth, and jet entry angle. The water level meniscus of the approach flow was clearly visible through the flume sidewall and on the video recording. By repeatedly measuring on the video recording the distance from the meniscus to the soil surface, a mean flow depth was obtained. Flow depth measurements were also made with a point gauge mounted on a carriage above the flume. Point gauge depth measurements were in

excellent agreement with those derived from the video recordings. During overland flow, water and sediment samples were obtained from the outlet pipe at regular intervals. Collected sediment samples were decanted, oven dried, and weighed to determine total sediment mass. At the conclusion of the run, a bed profile was taken along the flume's centerline using a point gauge. The depth of the scour trace relative to the bed surface was also measured along the flume sidewall.

There are two sources of error that could compromise the quality of the morphologic measurements obtained. First, the curvature of the video camera lens distorts the edges of the recorded image. By comparing known distances taken from the center and edges of the video frame, the maximum measurement errors for the headcut morphology ranged from 0.5 to 4.6% and the errors for flow depth measurement ranged from 3 to 10%. Second, operator variance was assessed by repeating measurements obtained from the same videotape on two different occasions. The maximum measurement errors for headcut morphology ranged from 1.3 to 6.6% and the error for the flow depth measurement was 5.2%.

3 RESULTS

3.1. General Description of Headcut Development and Migration

The general characteristics of headcut growth, development, and upstream migration were consistent in each experiment. At the beginning of each run, the overland flow passed over the pre-formed step, and the flow impinged on the surface seal just downstream of the step. The nappe at the brinkpoint is essentially a two-dimensional plane jet. This impinging jet caused surface seal failure and soil erosion, and a scour hole developed and enlarged. Jet entry angle as described herein is the acute angle the jet centerline forms with the water surface as is enters the backwater pool. In general, the scour hole rapidly increased its maximum scour depth S_D (the vertical distance from the headcut brinkpoint to lowest point within the scour hole; Figure 1e,f) and the length to the maximum scour depth S_L (the horizontal distance from the headcut brinkpoint to S_D; Figure 1g,h,i). The headcut brinkpoint is defined as the position where the nearly vertical headcut face intersects the horizontal soil bed on the upstream side. Concomitantly, erosion initiated at the brinkpoint and headcut migration ensued. The position of the headcut brinkpoint for each experiment varied linearly with time—that is, headcut migration rate was constant (Figure 1a,b,c). During this initial period of bed adjustment, scour depth S_D, scour length S_L, and sediment production increased (Figure 1). The peak in sediment yield S_Y coincided with initiation of both headcut movement and downstream deposition (Figure 1j,k,l). Once the scour hole attained an equilibrium or maximum depth, downstream deposition began, scour hole length was maintained, and sediment yield decreased. Along-flume profiles of the scour hole trace (erosional surface) show

that during each experiment depth of scour did not vary significantly (Figure 2, Table 1). Between the scour depth trace and the final bed surface was a region of deposition that represents a self-made bed.

After an initial period of bed adjustment, a steady-state condition ensued: a headcut of similar geometry migrated upstream at a constant velocity, producing both a constant rate of sediment yield and a constant rate of deposition in the downstream portion of the flume. For initial headcut heights of 30 mm and greater, the overfall jet became ventilated during the course of the experiment. The distance from the brinkpoint

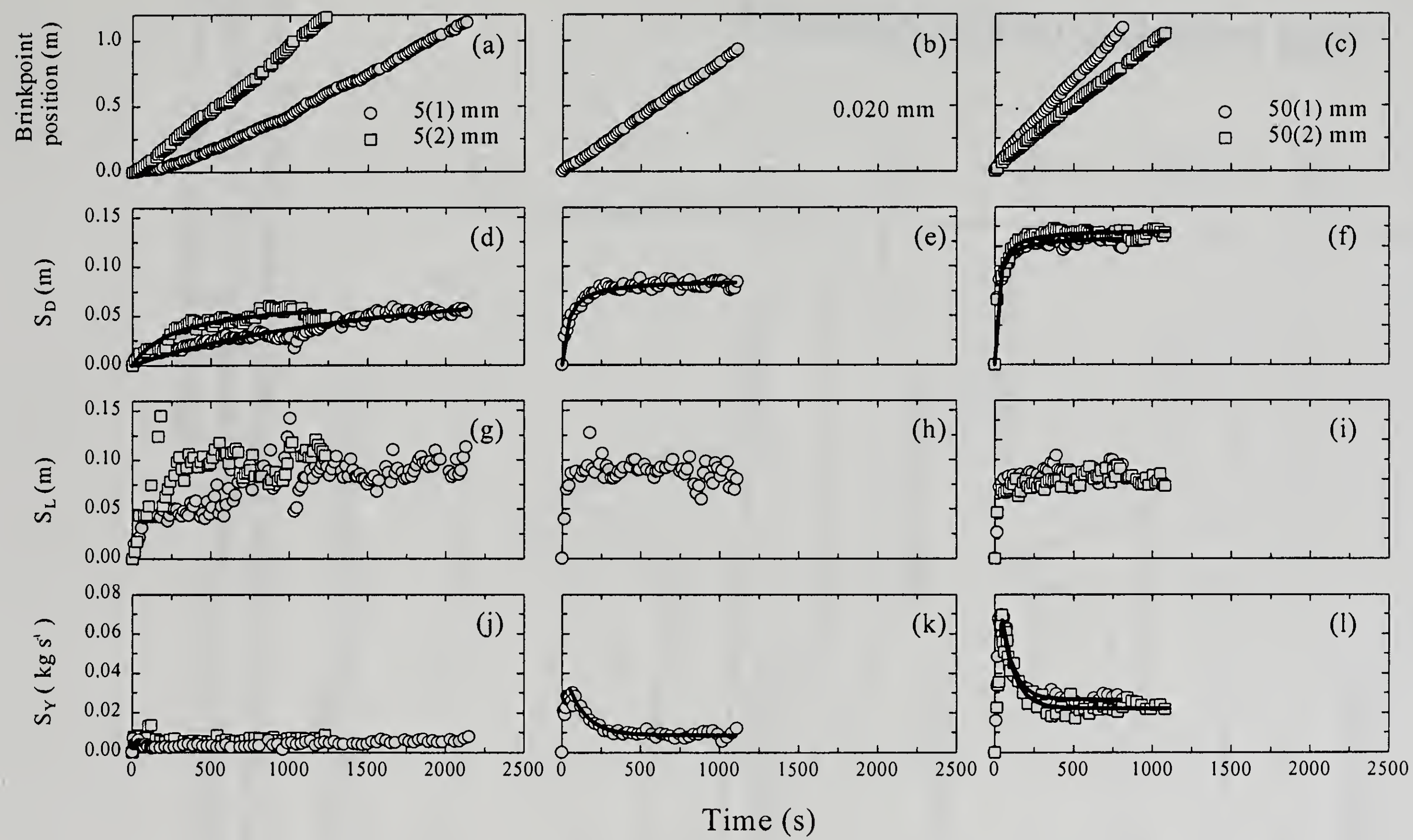

Figure 1. Time variation in headcut brinkpoint position, maximum scour depth S_D, length to maximum scour depth S_L, and sediment yield S_Y for experiments using initial headcut heights of 5 (a, d, g, j), 20 (b, e, h, k), and 50 mm (c, f, i, l). All data were measured at 15-s intervals. Also shown are asymptotic trend lines for S_D (a two-parameter hyperbolic function $S_D = (a \cdot t)/(b + t)$ where a is the asymptote of the time series, b is a coefficient, and t is time) and S_Y (a three-parameter exponentially decreasing function $S_Y = y_0 + ae^{-bt}$ where y_0 is the asymptote, a and b are coefficients, and t is time). Note that trend lines were not derived for (j) because these runs did not reach true steady-state conditions for the sediment transport parameters.

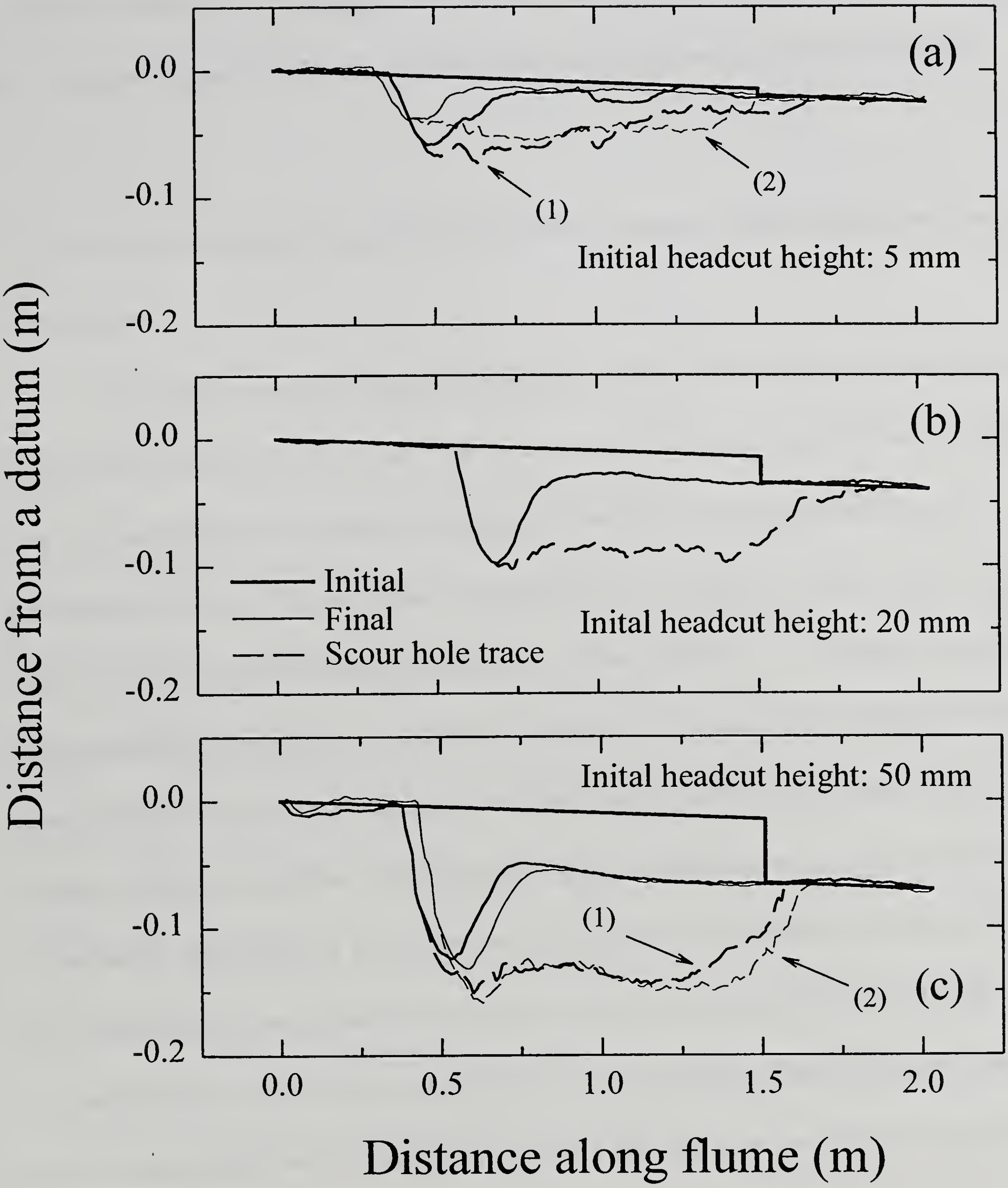

Figure 2. Along flume profiles of the initial and final bed surfaces and the trace of the scour depth for experiments with initial headcut heights of (a) 5, (b) 20, and (c) 50 mm. Flow is from left to right.

to the free surface of the plunge pool, which defines the overfall height, was about 10 mm. The time when ventilation occurred was noted for each experiment (Table 1).

3.2. Definition of Steady-State Erosion and the Time and Length Scales for Headcut Development

Steady-state erosion is reached when all variables that define headcut behavior do not change significantly with time. An important distinction is made between steady state for morphological variables and those for sediment transport variables. As described earlier, the time variation of maximum scour depth S_D, scour length S_L, and sediment yield S_Y tended towards asymptotic values (Figure 1). Of these, S_D most clearly demonstrated this asymptotic behavior. To better characterize this asymptotic variation, a two-parameter hyperbolic function was fitted to the values of S_D (Figure 1d,e,f). On average, derived correlation coefficients for these regressions were greater than 0.95. Considering a deviation of 10% from the asymptotic value, the time and distance required for a headcut given an initial size to reach steady state can be determined (Table 1, Figure 3). Initially large steps reach steady-state erosion conditions faster (by more than an order of magnitude) and over a shorter distance (by less than an order of magnitude) than do initially small steps.

Sediment yield was the selected variable to define steady-state conditions in terms of sediment transport. Because sediment yield climbs from zero to a maximum value, and then declines from a maximum value to an asymptote, a three-parameter

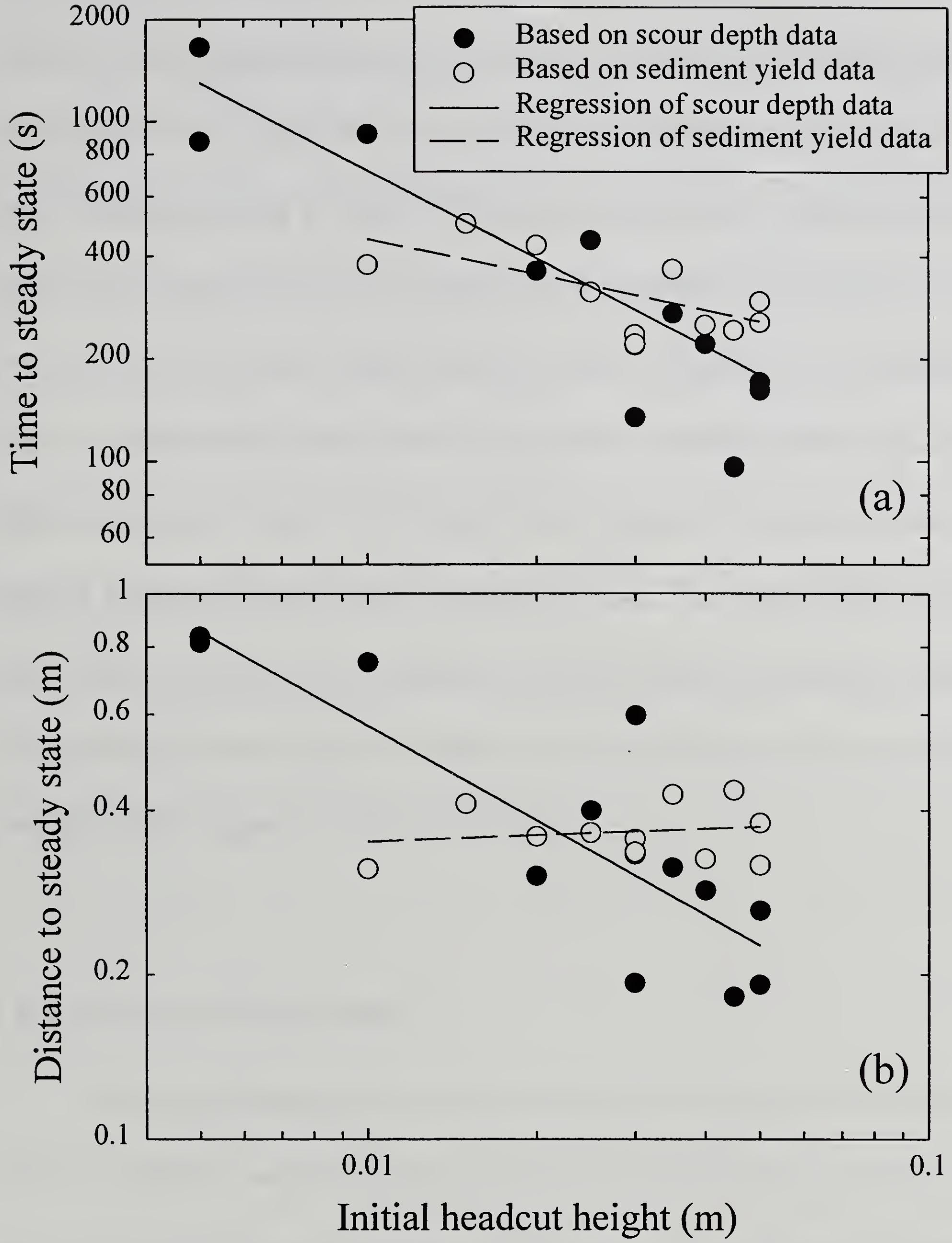

Figure 3. Variation of the (a) time and (b) distance required to reach steady-state soil erosion conditions based on scour depth and sediment yield data. Shown also are regression lines for each data set where (a) for scour depth *R*=0.91 and *PW*=1.0 (using α=0.05 and *P*=0.001), and for sediment yield *R*=0.67 and *PW*=0.64, and (b) for scour depth *R*=0.95 and *PW*=1.0, and for sediment yield *R*=0.17 and *PW*=0.0. *R* is the correlation coefficient of the regression line and *PW* is the probability that the regression correctly describes the relationship between initial headcut height and the dependent variable. For statistical significance, *R* and *PW* should be greater than 0.8.

exponentially decreasing function was fitted to the decaying section of the time series (Figure 1k,l). On average, derived correlation coefficients for these regressions were greater than 0.95. Again, the time and distance required to reach steady-state conditions were determined using the same 10% deviation criterion. Initially small steps take almost twice the amount of time to reach steady-state conditions for sediment transport parameters as do initially large headcuts (Table 1, Figure 3a). On the other hand, both initially small and large steps reach steady-state conditions after migrating about the same distance upstream (Figure 3b). Steady-state condition for deposit thickness must be reached at about the same time as sediment yield. For initial headcuts of 5 mm, a trend line could not be fitted to the sediment yield time series because these data did not attain an asymptotic value (Figure 1j)—that is, these runs did not reach true steady-state conditions with regard to sediment transport.

3.3. Replication of Experiments

Three experiments were repeated to assess the intrinsic variability of headcut and sediment transport parameters given nearly identical boundary conditions. Replicates were run for initial headcut heights of 5, 30, and 50 mm (Table 1). Although great care was taken during soil and bed preparation, the bulk soil densities for the 5 mm and 30 mm replicates differed by about 8%. Such changes in bulk density may be due to variation in soil moisture content, soil texture and composition, and energy expended during the packing process.

Tests were performed to determine if there existed a statistically significant difference between the morphologic and sedimentological results obtained in each replicated experiment. For these, instantaneous values of the following parameters were examined after steady-state conditions were achieved: migration rate, S_D, S_L, S_L/S_D, jet entry angle, S_Y, and deposit thickness. The results from these statistical tests are summarized in Table 2. In general, S_D, S_L/S_D, jet entry angle, S_Y, and deposit thickness show no statistical difference in at least two sets of repeated experiments. Migration rate and S_L show statistical differences in two sets of repeated experiments. The lack of complete repeatability may be due to the limited number of replicated runs. *Bennett et al.* [2000] repeated the same headcut experiment four times. Using an initial headcut height of 50 mm and a flow discharge close to 71.0 l min^{-1}, the percent variation was reported for the following parameters: 1.6% for soil bulk density, 4.9% for final runoff rate, 0.9% for flow discharge, 10.4% for migration rate, 3.2% for maximum scour depth S_D, 7.8% for length to maximum scour depth S_L, and 7.5% for sediment yield S_Y. These results show that migration rate and S_L have the largest potential variability.

The greatest variability observed between repeated runs was using an initial headcut height of 30 mm, but these runs had markedly different overfall nappes. In run 30(1), the overfall nappe remained submerged (nonventilated) for the entire experiment, whereas in run 30(2) the overfall became ventilated after about 126 s of elapsed time (Table 1). *Bennett* [1999] showed that steady-state conditions for ventilated nappes were markedly different from nonventilated nappes.

The repeatability of the experimental results also extends to the bed profiles and scour hole traces. For repeated runs using the 5 mm headcut height, the bed profiles and scour hole traces are similar but not identical (Figure 2a). But for the repeated experiments using the 50 mm headcut height, these bed profiles are virtually identical, including the subtle adjustments within the scour trace (Figure 2c). These scour trace adjustments are related to the effect of differing bed slopes between the original bed and the sediment deposit (see discussion in *Bennett et al.*, 2000].

Table 2. Statistical comparison of steady-state parameters for each experiment with the same initial headcut height. The Kruskals-Wallis ANOVA on ranks was selected to determine if there exists a statistically significant difference in the measured experimental parameters (using α=0.05 and P=0.001). If the groups are statistically different, the experimental parameter is denoted as D. If no statistical difference exists, then the parameter is denoted as E.

Parameter	Initial Headcut Height (mm)		
	5	30	50
Migration rate	D	E	D
Scour depth	E	E	E
Scour length	E	D	D
S_L/S_D	E	E	E
Jet entry angle	E	D	E
Sediment yield	E	E	E
Deposit thickness	E	D	E

3.4. Sediment Sorting and Bulk Soil Density

Texture of the soil material was determined by separating the soil into sand, silt, and clay size fractions. Total percent sand by mass was determined by wet sieving the dispersed soil sample through a 0.05-mm sieve. Total percent clay (<0.002 mm) by mass

was determined using the pipette method [*Vanoni*, 1975]. Total percent silt was determined by adding the masses of sand and clay and subtracting these from the total sample mass. For the bulk soil material, five randomly selected samples were analyzed. For the sediment yield, four samples were analyzed for select experiments, obtained during steady-state conditions. For the sediment deposit, three or four samples were analyzed for select experiments, extracted using aluminum cylinders either 0.025 or 0.051-m deep and 0.048 m in diameter. Soil bulk density was also determined for the sediment deposit samples.

On average, the bulk sediment mixture was composed of 64.6% sand, 8.3% silt, and 27.1% clay by mass (Table 3). Figure 4 and Table 3 compare the grain size distributions of the sediment yield and the deposit with the bulk soil material. In general, the sediment yield had a sand content of 57.6%, a silt content of 12.1%, and a clay content of 30.3%. This represents an enrichment of 46% and 12% in silt and clay content, respectively, and a depletion of 11% in sand content as compared to the original soil material. While the removal of silt and clay from agricultural lands depletes soil productivity, these size fractions also are more likely to be transporting agrichemicals [see review in *Leonard*, 1990]. Conversely, the sediment deposit generally had a sand content of 77.6%, a silt content of 4.2%, and a clay content of 18.2%. This represents an enrichment of 20% in sand content, and a depletion of 50% and 33% in silt and clay content, respectively, as compared to the original soil material. Given the presence of silt and clay in the deposit, a significant proportion of these sediment sizes were eroded,

[illegible]

[illegible]

transported, and deposited as aggregates. The textural characteristics of the sediment yield and the sediment deposit showed no dependency on initial headcut height.

Table 3. Textural analyses given as percent by mass for sediment yield and the self-made bed for select experiments and for the bulk sediment mixture.

Initial Headcut Height (mm)	Sediment Yield			Self-made Bed		
	Sand (%)	Silt (%)	Clay (%)	Sand (%)	Silt (%)	Clay (%)
5(1)	65.5	9.4	25.1	78.2	0.3	21.5
	62.2	10.2	27.6	76.0	6.1	17.9
	64.3	9.6	26.1	77.1	5.9	17.0
	64.8	8.1	27.1	---	---	---
5(2)	60.5	10.6	28.9	79.7	5.3	15.0
	52.9	11.0	36.1	79.6	5.0	15.4
	51.9	13.9	34.2	78.5	5.6	15.9
	55.9	9.9	34.2	79.1	5.0	15.9
10	59.2	13.7	27.1	78.1	6.3	15.6
	57.2	13.3	29.5	77.1	5.9	17.0
	59.0	12.8	28.2	77.5	6.6	15.9
	54.9	13.8	31.3	78.9	6.0	15.1
15	---	---	---	78.9	1.4	19.7
	---	---	---	79.4	1.7	18.9
	---	---	---	75.6	1.9	22.5
	---	---	---	77.1	2.5	20.4
20	51.8	15.5	32.7	77.6	3.8	18.6
	53.8	13.8	32.4	78.1	3.9	18.0
	56.6	11.0	32.4	78.0	2.9	19.1
	51.6	12.9	35.5	78.3	3.9	17.8
30(2)	51.5	15.2	33.3	75.8	5.6	18.6
	50.4	17.0	32.6	76.1	1.0	22.9
	52.4	15.8	31.8	77.4	3.6	19.0
	59.0	12.0	29.0	---	---	---
40	---	---	---	80.1	3.5	16.4
	---	---	---	78.4	4.1	17.5
	---	---	---	80.5	3.7	15.8
45	63.9	9.6	26.5	81.2	2.7	16.1
	65.8	8.4	25.8	78.8	2.6	18.6
	64.0	9.1	26.9	81.9	2.9	15.2
	65.4	8.7	25.9	81.3	3.4	15.3
50(1)	62.0	11.4	26.6	78.7	2.3	19.0
	60.1	12.2	27.7	80.0	2.8	17.2
	60.6	12.2	27.2	79.8	2.2	18.0
	59.2	12.6	28.2	79.1	1.4	19.5
50(2)	49.2	13.9	36.9	68.6	8.3	23.1
	52.8	13.0	34.2	69.1	8.3	22.6
	51.8	12.6	35.6	70.5	7.5	22.0
	52.6	13.4	34.0	71.2	8.0	20.8
Bulk Mixture	64.2	7.8	28.0	---	---	---
	65.0	8.1	26.9	---	---	---
	64.8	8.1	27.1	---	---	---
	64.6	8.3	27.1	---	---	---

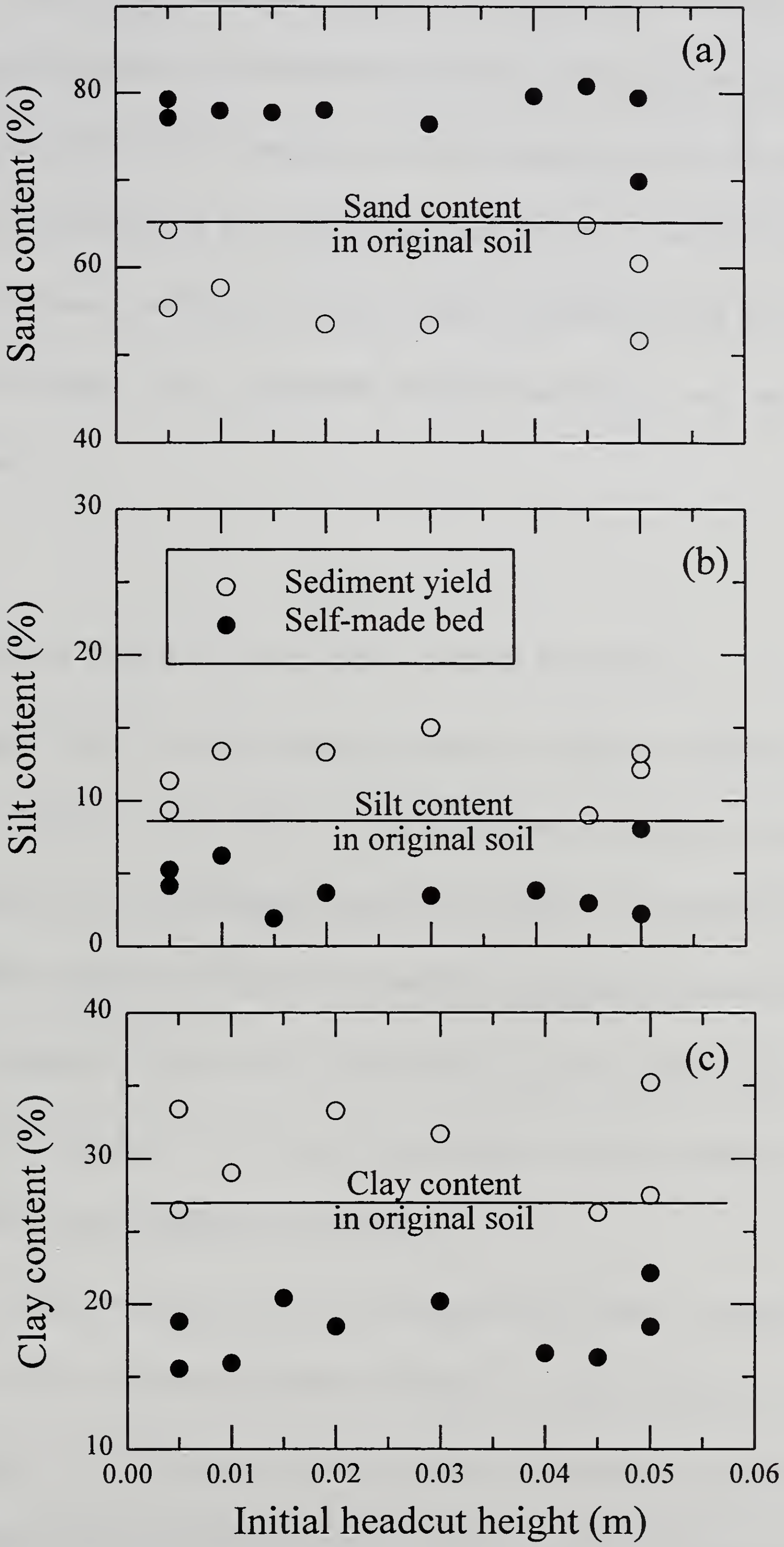

Figure 4. Variation of sediment texture for sediment yield and self-made bed with initial headcut height. Also shown are the sand, silt, and clay content of the original soil material.

The bulk density of the sediment deposit was always lower than the packed soil bed (Table 1). The bulk density of the deposit was 1% to 13% less dense than the packed soil bed (7.8% on average). The reduction in bulk density can be explained by the change in sediment texture and by how the deposit was formed. The higher proportion of sand presumably increased sediment porosity, hence decreasing bulk soil density. In addition, these sediments were deposited hydrodynamically and not compacted mechanically in place.

3.5. Effect of Initial Step Height on Steady-State Headcut Parameters

Time-averaged values for steady-state parameters related to headcut morphology are summarized in Figure 5 and Table 1. As initial step height increased, headcut migration rate increased (not statistically significant; Figure 5a), maximum scour depth increased (statistically significant; Figure 5b), length to maximum scour depth decreased (not statistically significant; Figure 5c), and headcut aspect ratio S_L/S_D decreased (statistically significant; Figure 5d). The jet entry angle also increased as initial step height increased (statistically significant; Figure 5e).

Two other steady-state parameters also increased with initial headcut height. The effective tailwater height, defined as the ratio of depth of water within the scour hole to maximum scour depth T_W/S_D, decreased from about 1.15 to about 0.76 (Table 1)—that is, the larger steps had smaller tailwater heights. Also, the projected angle of inclination of the headcut face (Table 1), defined as $\tan^{-1}(S_D/S_L)$, increased from about 30° to about 55°—that is, larger headcuts had steeper erosional faces. For a given bed slope and

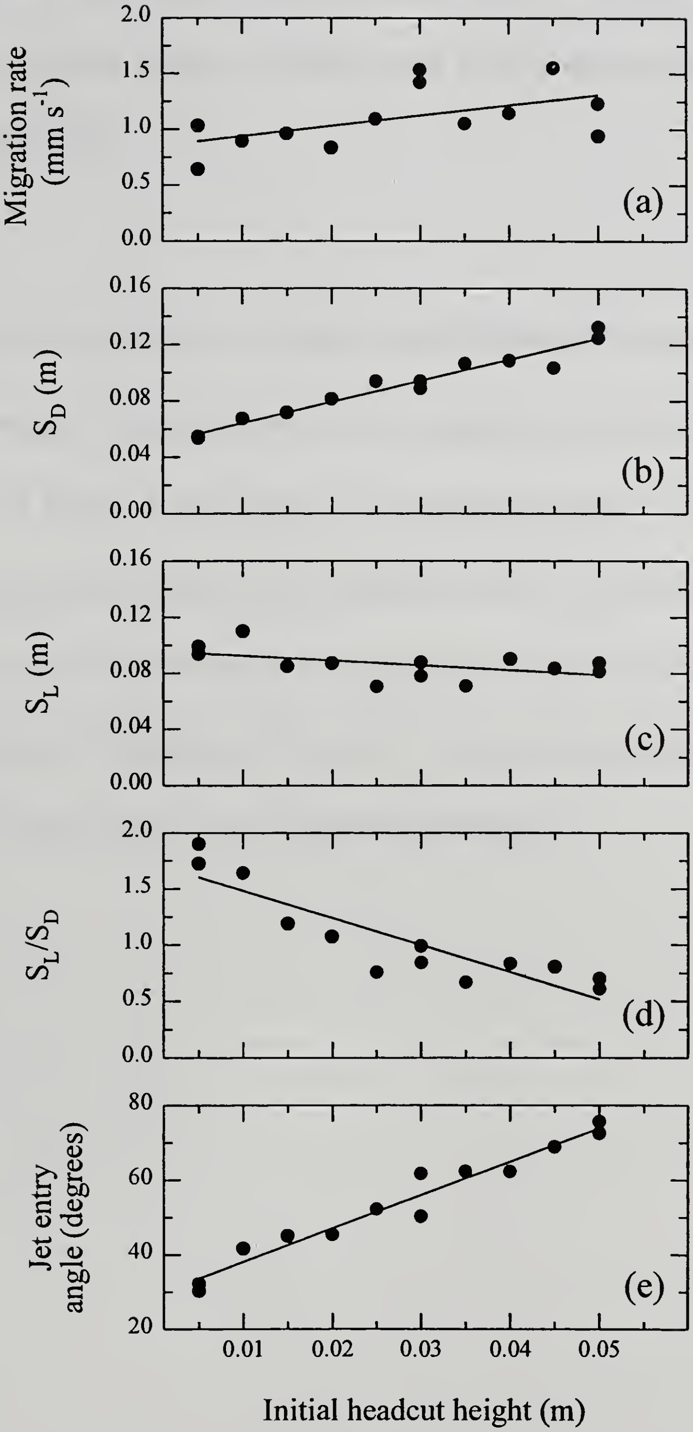

Figure 5. Variation of steady-state headcut parameters with initial headcut height. Shown are (a) headcut migration rates (*R*=0.55; *PW*=0.49; using α=0.05 and *P*=0.001), (b) maximum scour depth S_D (*R*=0.97; *PW*=1.0), (c) length to maximum scour depth S_L (*R*=0.51; *PW*=0.42); (e) the ratio S_L/S_D (*R*=0.89; *PW*=1.0), and (f) jet entry angle *R*=0.98; *PW*=1.0).

overland flow discharge, larger initial steps caused the formation of deeper, steeper headcuts with ventilated nappes but their rates of migration and their scour lengths did not change significantly.

3.6. Effect of Initial Step Height on Steady-State Sediment Transport Parameters

Time-averaged values for steady-state parameters related to sediment transport are summarized in Figure 6 and Table 1. As initial step height increased, sediment yield, deposit thickness, and the slope of the sediment deposit increased (each statistically significant). For a given bed slope and overland flow discharge, larger initial steps caused the formation of headcuts with greater rates of sediment production, deposition, and yield and a steepening of the bed slope downstream.

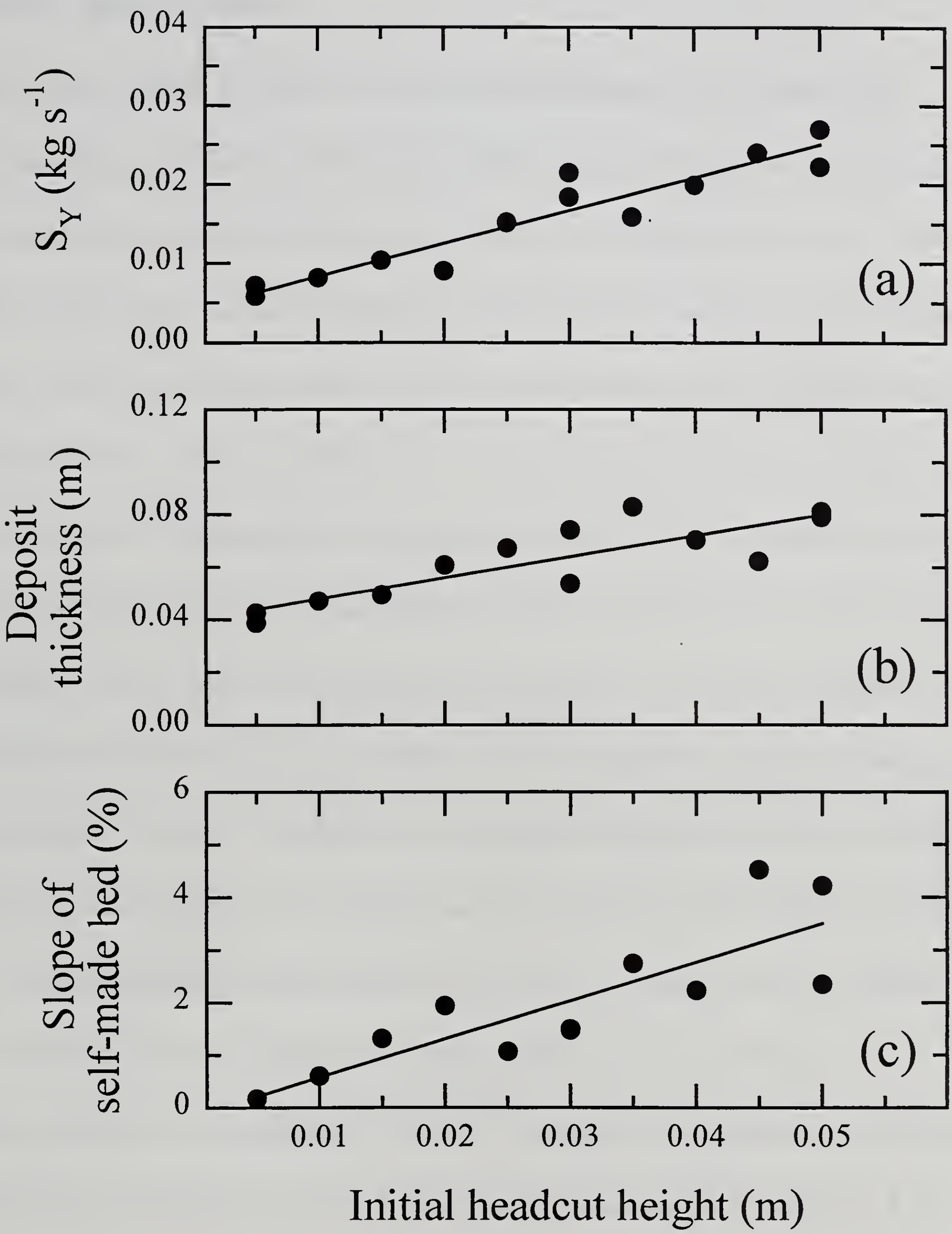

Figure 6. Variation of steady-state sediment transport parameters with initial headcut height. Shown are (a) sediment yield (*R*=0.95; *PW*=1.0; using α=0.05 and *P*=0.001), (b) deposit thickness (*R*=0.85; *PW*=0.98, and (c) slope of self-made bed (*R*=0.84; *PW*=0.96).

4 DISCUSSION

4.1. Systematic Headcut Erosion

Although a variety of causes for headcut development in soils have been observed, including the effects of the soil and surface material characteristics and the nature of overland and subsurface flow [e.g., *Mosley*, 1974; *Bryan and Poesen*, 1989; *Bryan*, 1990; *Bryan and Oostwouud Wijdenes*, 1992; *Slattery and Bryan,* 1992; *Römkens et al.*, 1996, 1997; *Bryan and Rockwell*, 1998], experimental results presented here and elsewhere have shown systematic behavior in headcut erosion processes. On bed slopes 2% and lower, for flow discharges ranging from 20 to 80 l min^{-1}, and with initial headcut heights ranging from 5 to 50 mm, steady-state headcut erosion has been observed where headcut migration rate, scour hole geometry, and sediment yield reach asymptotic values [see also *Bennett* 1999; *Bennett et al.*, 2000]. For bed slopes 3% and greater using a flow discharge of about 52 l min^{-1}, constant headcut migration rate has been reported but steady-state scour hole dimensions were not achieved because of the length limitation of the flume. Taken separately, these results show that S_D, S_L, and S_Y could be simple empirical functions of flow discharge, bed slope, and initial headcut height.

This presumption is misleading, however, because other parameters need to be quantified before an analytical solution for headcut erosion can be completed. For example, *Bennett et al.* [2000] observed the following relations using similar upstream boundary conditions and nearly identical soil materials: $S_D \approx Q^{0.87}$, $S_L \approx Q^{0.89}$, and $S_Y \approx Q^{0.44}$. The application of these relations to the data presented herein would lead to erroneous results because they do not take into account the effect of tailwater height on

modulating the characteristics of the impinging jet including its angle, its length to impingement, and its erosivity [e.g. *Donnelly and Blaisdell*, 1965; *Blaisdell and Anderson*, 1988; *Bormann and Julien*, 1991; *Robinson and Hanson*, 1996]. For small initial headcut heights, tailwater height was relatively high and both jet entry angle and the angle of inclination of the headcut face were relatively low (Table 1). During some experiments, particularly with initial headcut heights of 5 and 10 mm, the overfall jet was observed to float periodically, at which time no scour hole erosion took place. Conversely for large initial headcut heights, tailwater height was relatively low and both jet entry angle and the angle of inclination of the headcut face were relatively high (Table 1). *Stein et al.* [1993] recognized that jet diffusion plays an important role in headcut erosion where the dominant process is plunge-pool scour. But their analytical model, which incorporated the characteristics of the impinging jet, was limited to those cases where the depth of the tailwater was small relative to the scour hole depth. For gully headcuts with ventilated nappes, *Robinson and Hanson* [1994] developed a model for gully headcut advance that included the effect of tailwater height on the magnitude of stress at impingement. But their model did not consider erosion within the impingement area—that is, no scour hole erosion, nor the effect of downstream deposition, which also must modulate tailwater and jet characteristics. These considerations are further exacerbated in developing headcuts where the characteristics of the impinging jet and the height of the sediment deposit downstream of the scour hole are time dependent.

The asymptotic depth of scour below a headcut depends on upstream and downstream boundary conditions, the characteristics of the impinging jet, and the

erodibility of the sediment (see references above). For the runs presented here, the upstream boundary conditions and soil material were nearly identical, but the characteristics of the jet and the downstream boundary condition, namely jet entry angle and tailwater height, respectively, were not. As initial headcut height increased, the tailwater height decreased and the jet entry angle and asymptotic scour hole depth increased.

4.2. Evolution of Bed Microtopography

Based on information presented here and elsewhere, there are two important parameters that determine the growth and evolution of headcut scour holes and hence soil losses in upland concentrated flows: (1) the time and length scales required for headcut development, and (2) the adjustment of headcut dimensions to discharge, slope, and soil materials. The formation of microstep headcuts and their enlargement during upstream migration is commonly observed in rill erosion studies [e.g., *Bryan and Poesen*, 1989; *Bryan*, 1990; *Bryan and Oostwoud Wijdenes*, 1992]. As long as flow discharge, bed slope, and sediment characteristics remain the same during headcut migration, there is a strong relationship between the height of an initial headcut and the time and length required to reach steady-state conditions (Figure 3). Such constancy is possible in field situations, but over small spatial and temporal scales.

A migrating headcut is more likely to encounter a decrease in flow discharge and changes in bed slope or material characteristics or both. *Parker* [1977] and *Begin et al.* [1980a,b] observed a reduction in the size and rate of migration of knickpoints as they

progressed upstream in response to a decrease in basin area (discharge). *Bennett et al.* [2000] observed a systematic decrease in the size of headcuts as flow discharge decreased. For upland areas susceptible to headcut development, a polymodal distribution of headcut sizes, shapes, and migration rates would be expected on a landscape as a result of microsteps growing and adjusting to flow discharge, bed slope, and soil material characteristics.

5 SUMMARY AND CONCLUSIONS

The present study sought to extend an existing experimental methodology by examining for a given slope, overland flow discharge, and soil the effect of initial step height on headcut growth and development, steady-state scour hole dimensions, migration rate, and sediment yield. Although steady-state headcut erosion conditions were observed in each experiment, the time and length required reaching this state decreased as the initial headcut height became larger. Smaller initial step heights caused the formation of progressively smaller headcuts with lower sediment yields, thinner sediment deposits, shallower jet entry angles, and lower bed slopes of the sediment deposit as compared to larger initial headcut heights. These effects were controlled by a relatively higher tailwater height that decreased the erosivity of the impinging jet, thereby limiting the depth of scour. In comparison to the packed soil bed, the sediment yield was enriched in silt and clay and depleted in sand, and the sediment deposited downstream of the headcut was enriched in sand and depleted in silt and clay. The sediment deposit had a lower bulk density than the packed soil bed because it had a higher porosity due to sand enrichment, and silt and clay were deposited in aggregate form. These results provide additional information useful in developing soil erosion prediction technology and for the evolution of bed microtopography in upland areas susceptible to headcut erosion.

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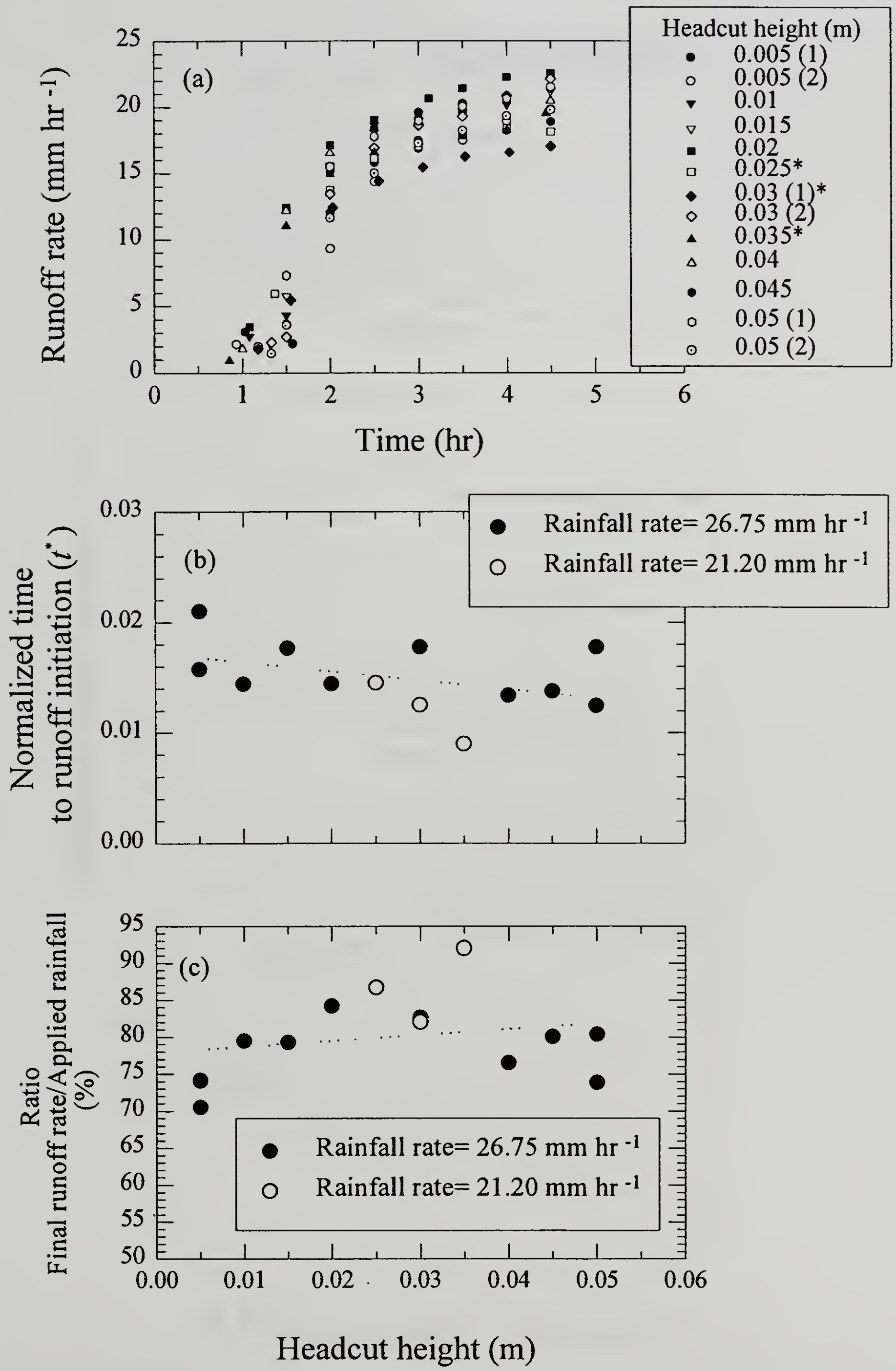
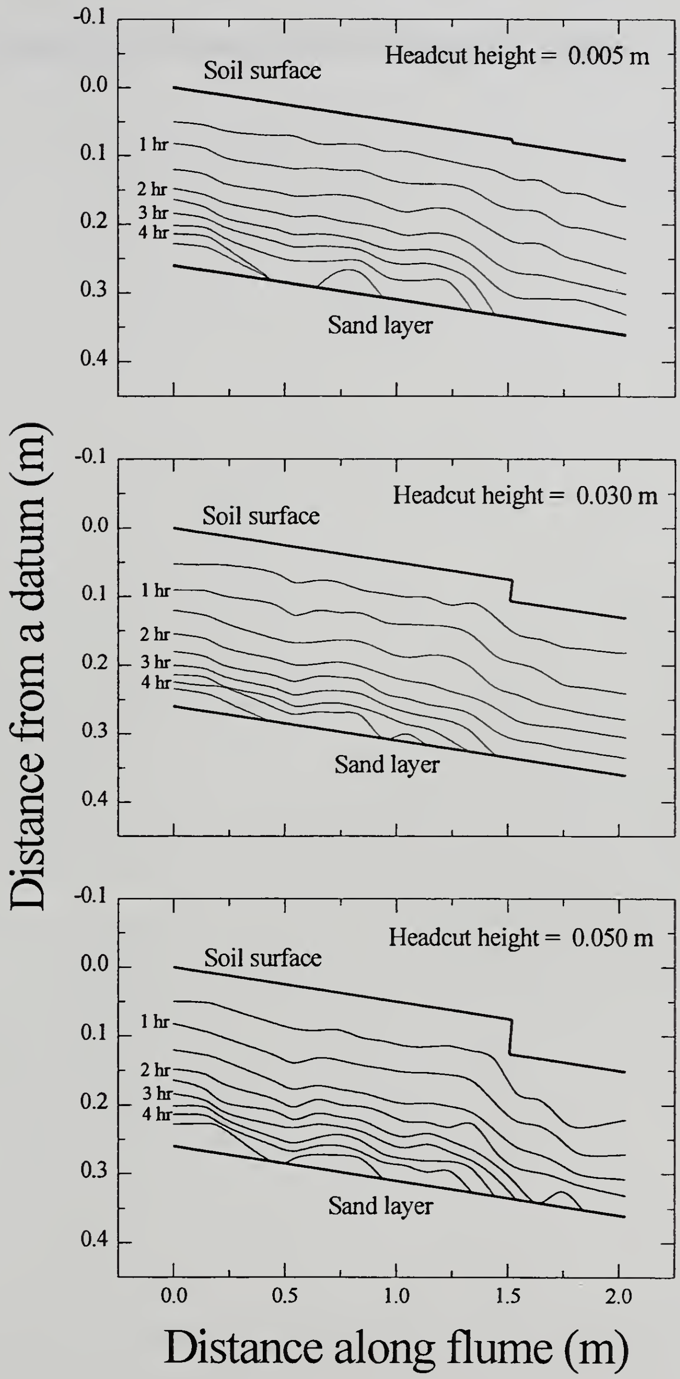
APPENDIX A:

Bed Preparation: Rainfall application, runoff rates, and the procession of the wetting front.



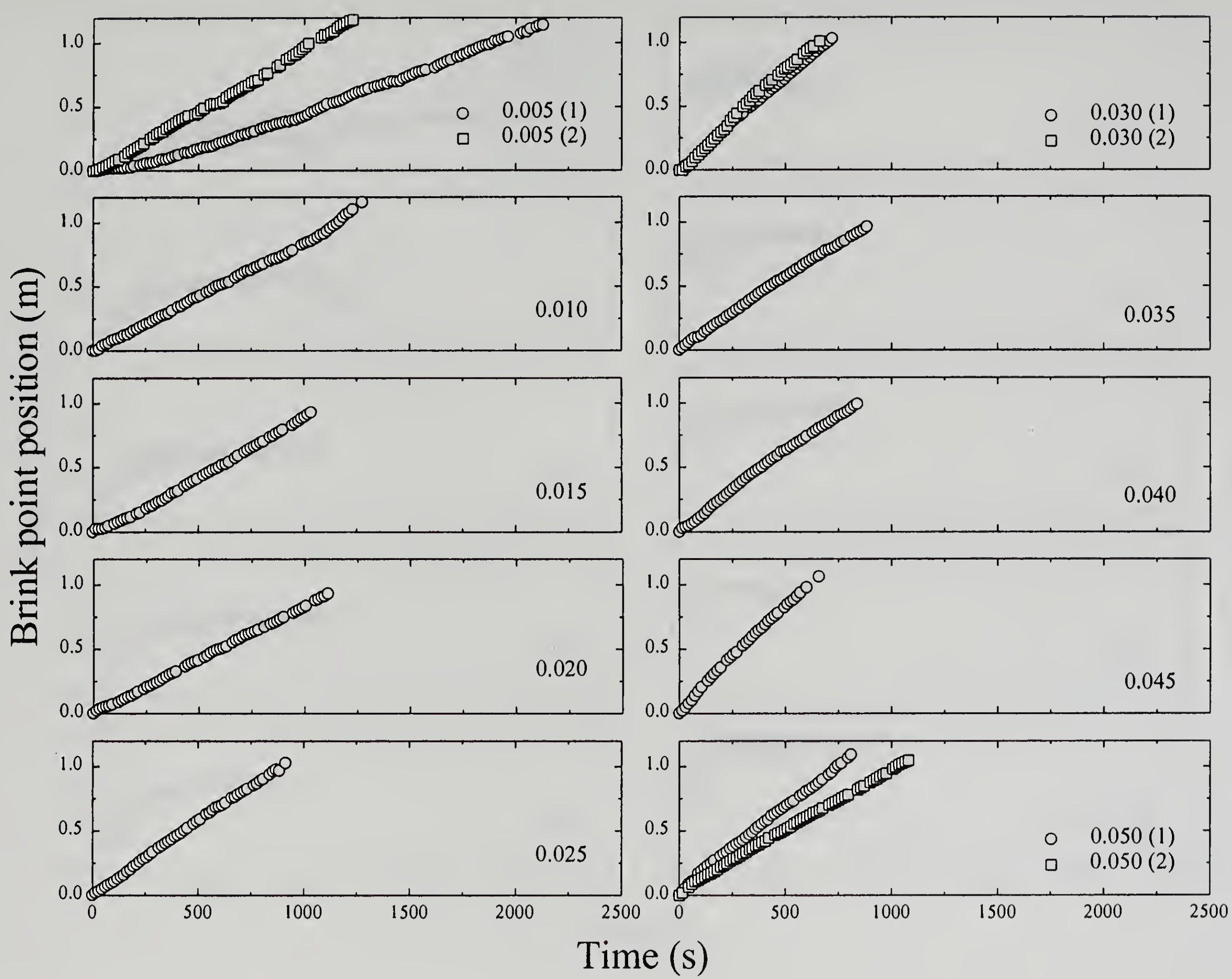
(a) Time variation in surface runoff rate measured at 30-min intervals for all experiments. (b) Normalized time to runoff inception for all experiments. $t^* = \dfrac{t \cdot R}{L}$**, where *t* is time to inception (h), *R* is rainfall rate (mm/h) and *L* is channel length (m). (c) Ratio between final runoff rate and applied rainfall for all experiments.**



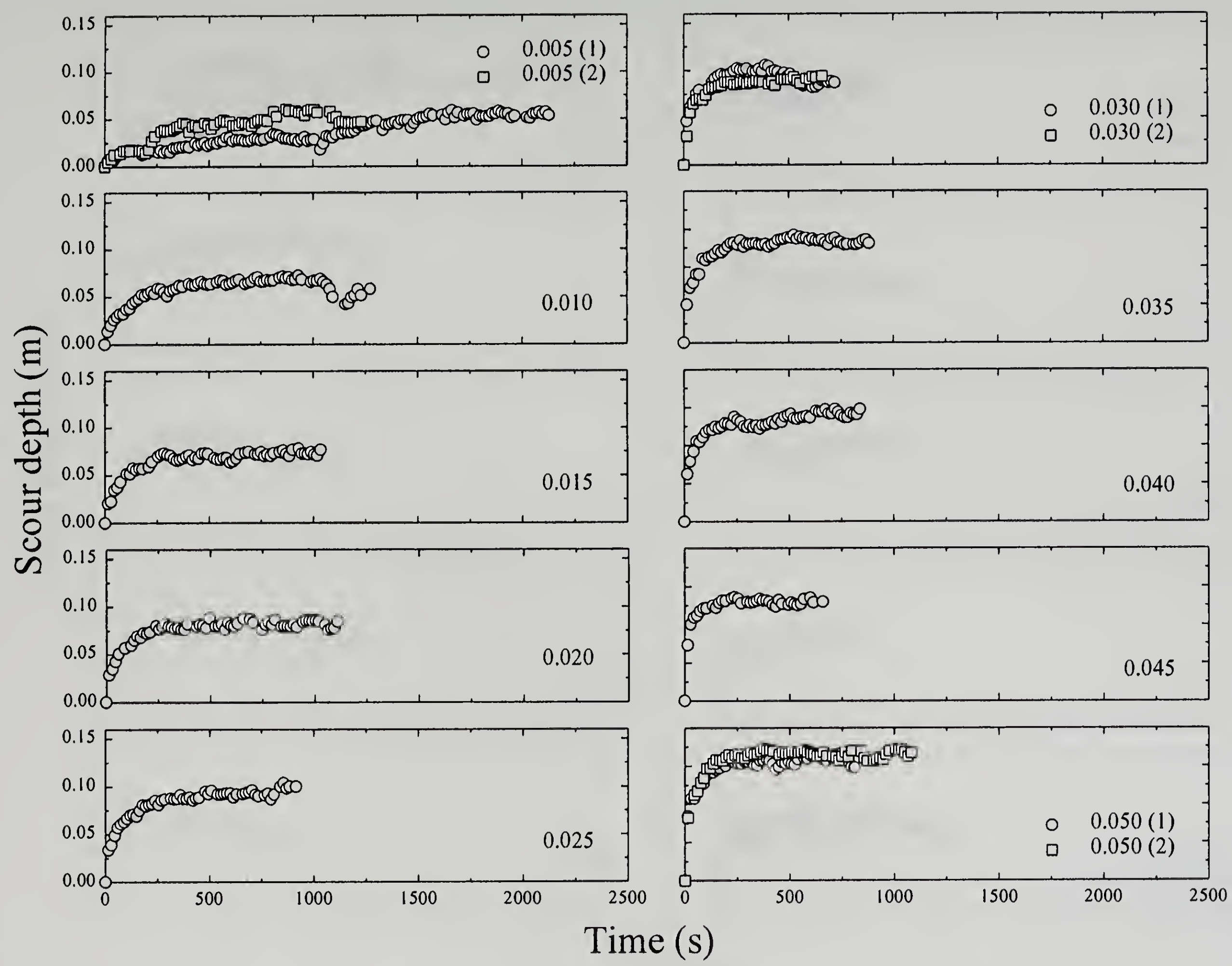
Procession of the wetting front through the soil profile as observed from the flume sidewall for runs 0.005(1), 0.030(2) and 0.050(1).

APPENDIX B:

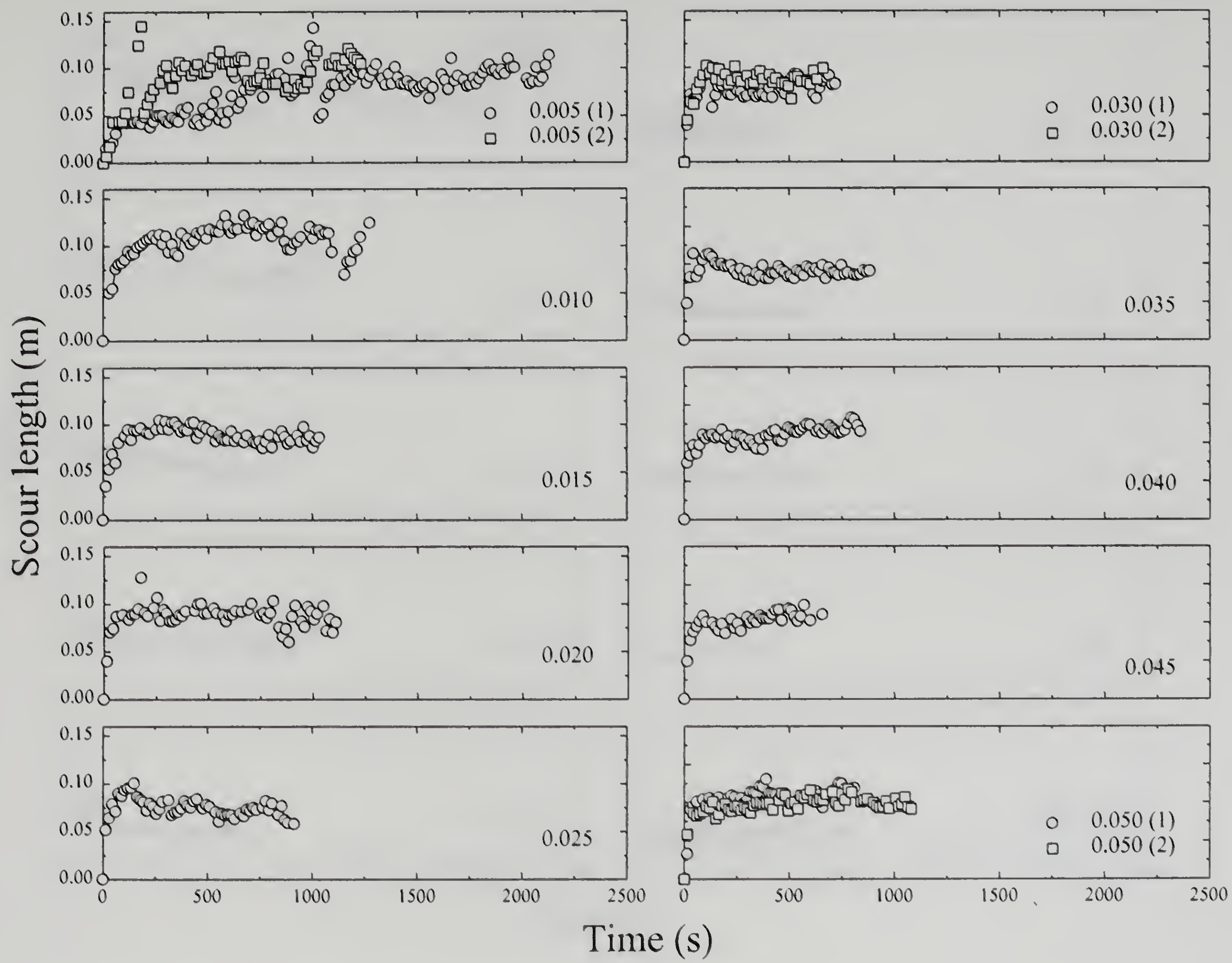
Time evolution of brink-point position, scour depth, scour length, scour length-depth ratio, overfall jet angle, and sediment yield during experiments.



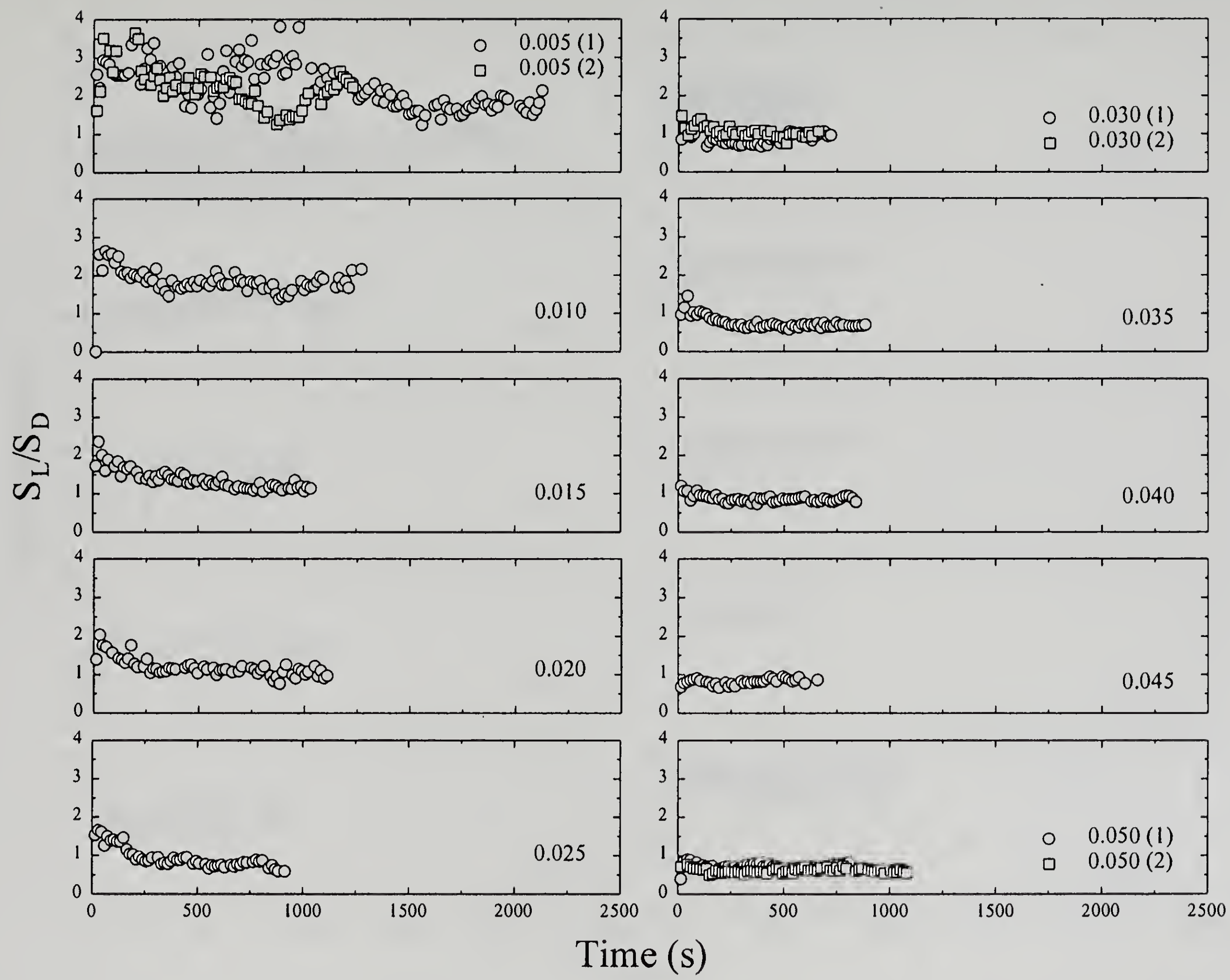
Time variation in headcut brinkpoint position measured at 15-s intervals.



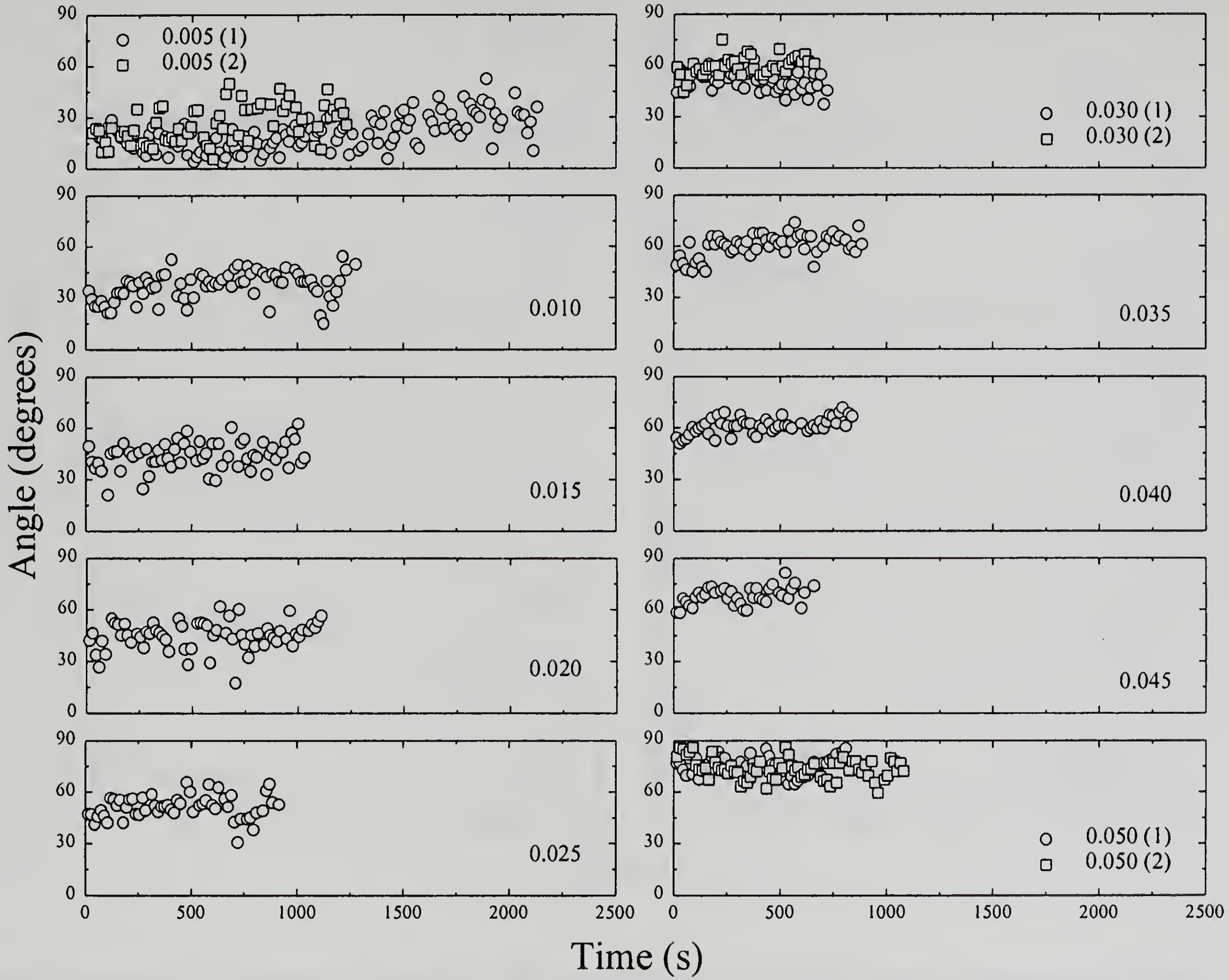
Time variation of maximum scour depth S_D measured at 15-s intervals.



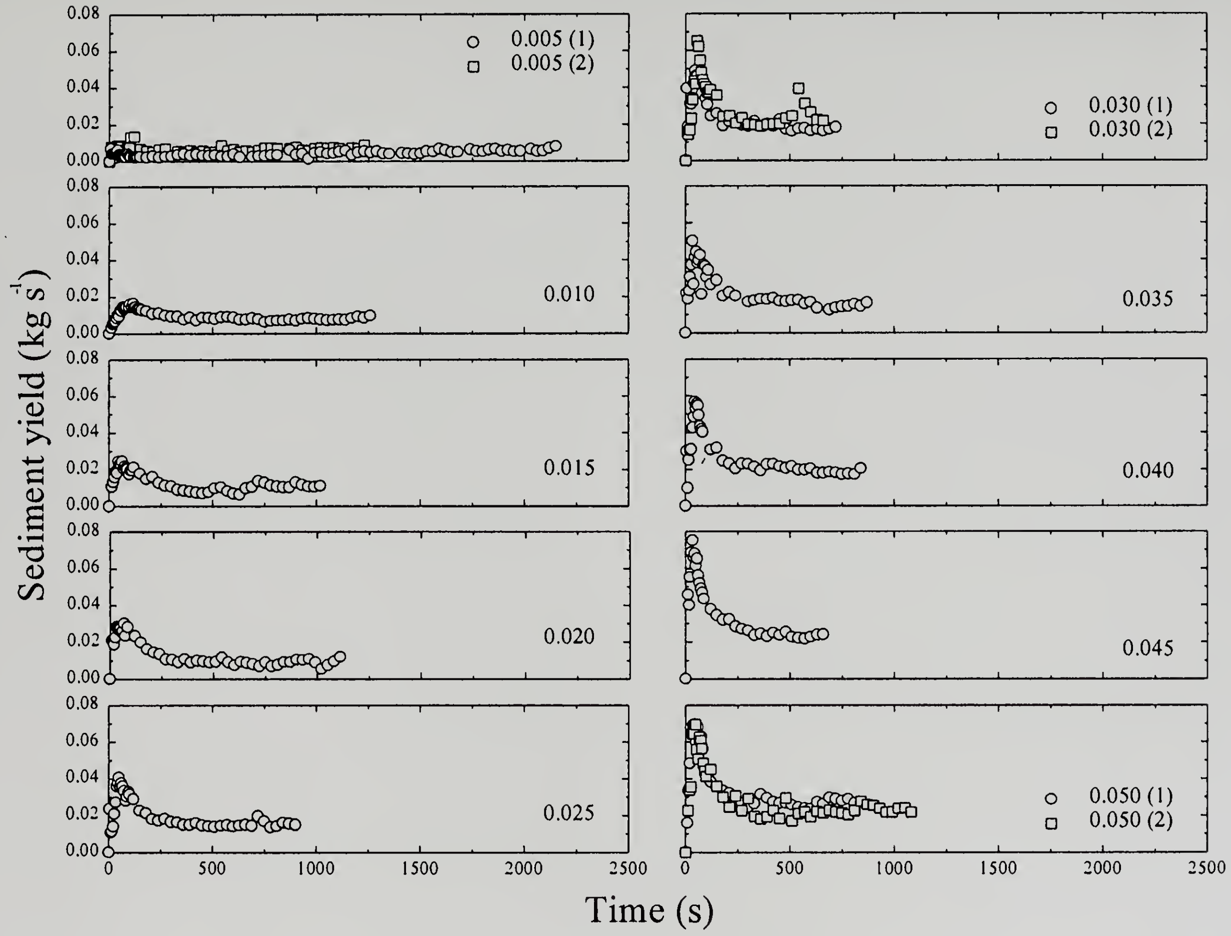
Time variation in headcut length at 15-s intervals.



Time variation in the ratio of the length to the maximum scour depth-to-maximum scour depth S_L/S_D measured at 15-s intervals.



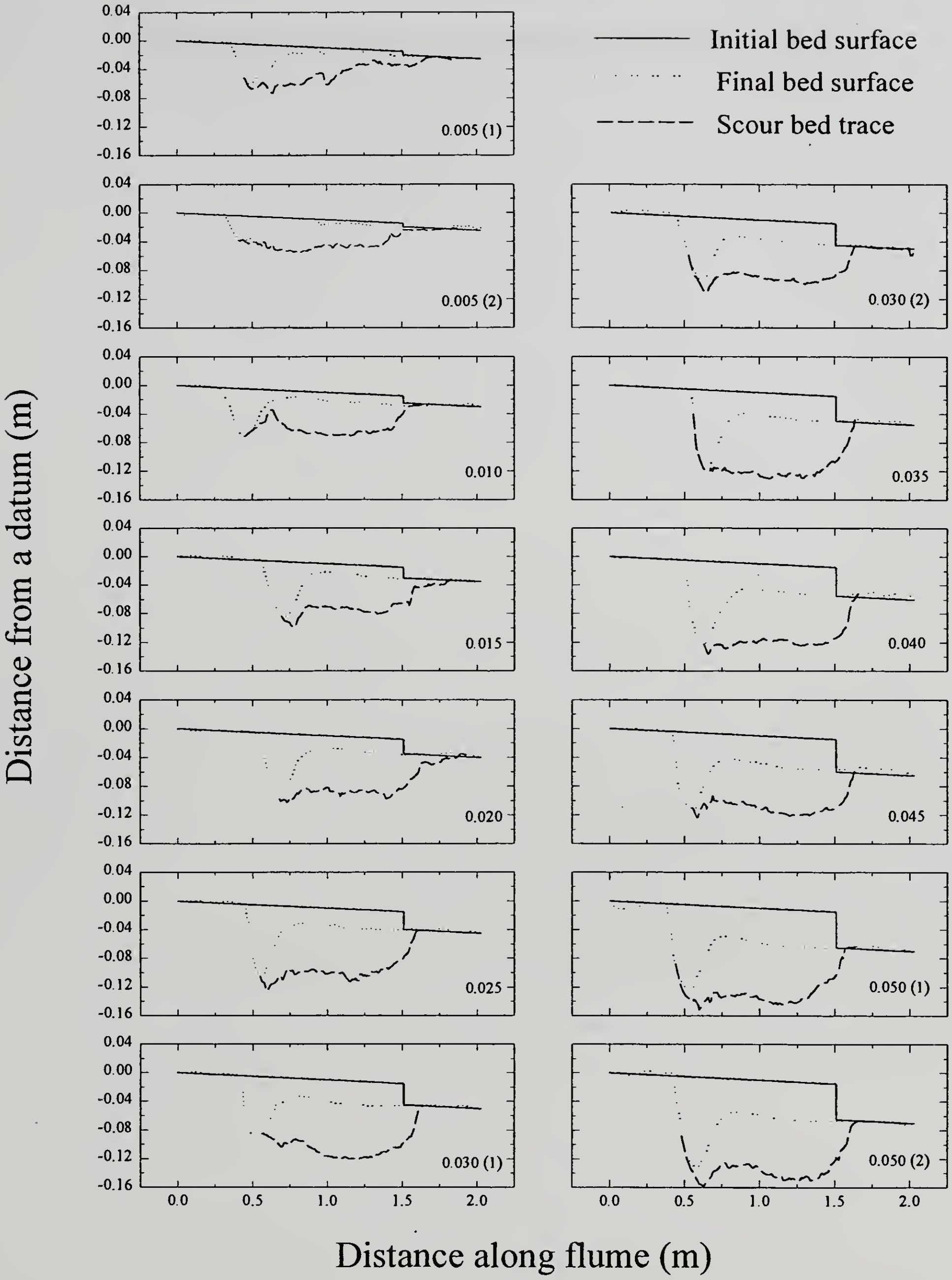
Time variation in jet angle measured at 15-s intervals.



Time variation in sediment yield for all experiments. Samples were obtained as fast as possible until the headcut form and its migration rate had stabilized, and thereafter at 30-s intervals.

APPENDIX C:

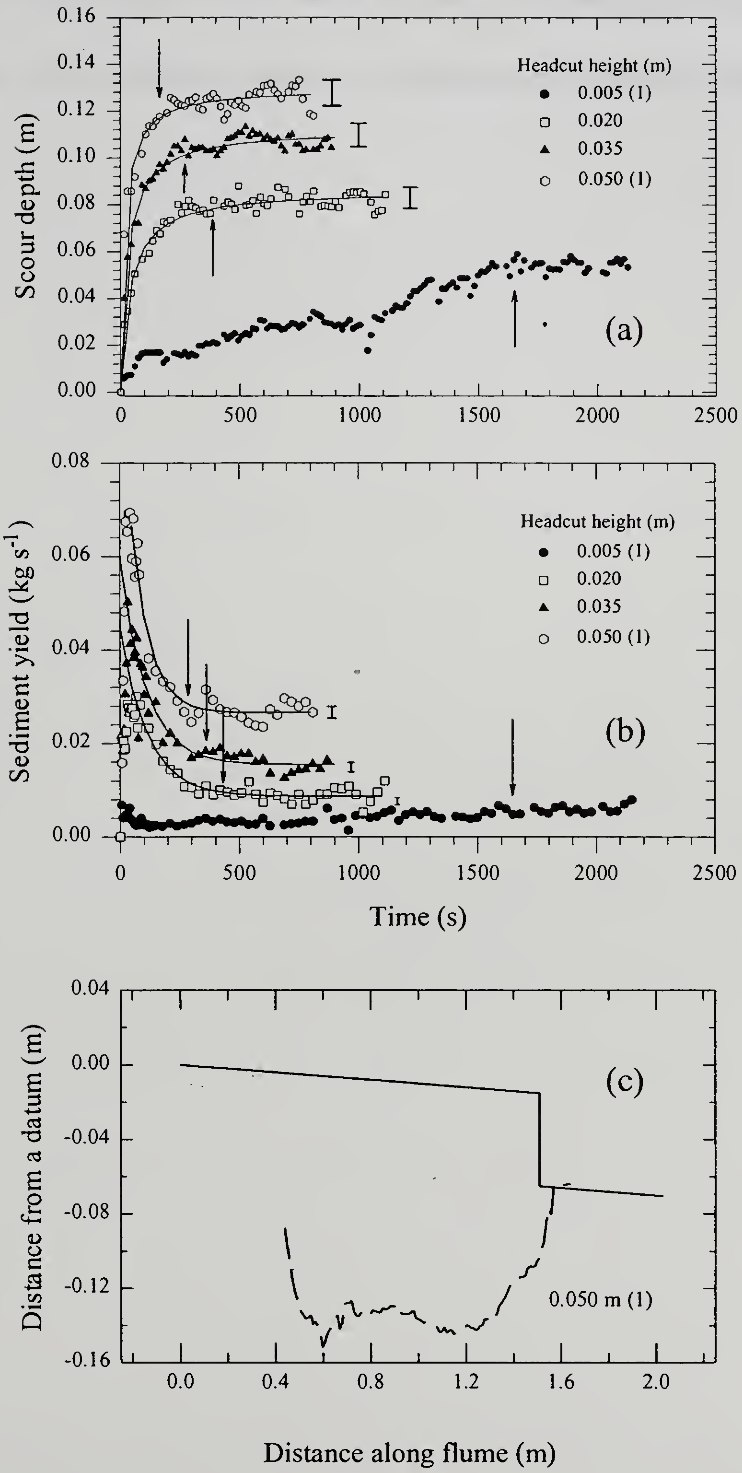
Along flume profiles of the initial and final bed surface, and the trace of the scour depth for all experiments.



Along flume profiles of the initial and final bed surface, and the trace of the scour depth for all experiments. Flow is from left to right.

APPENDIX D:

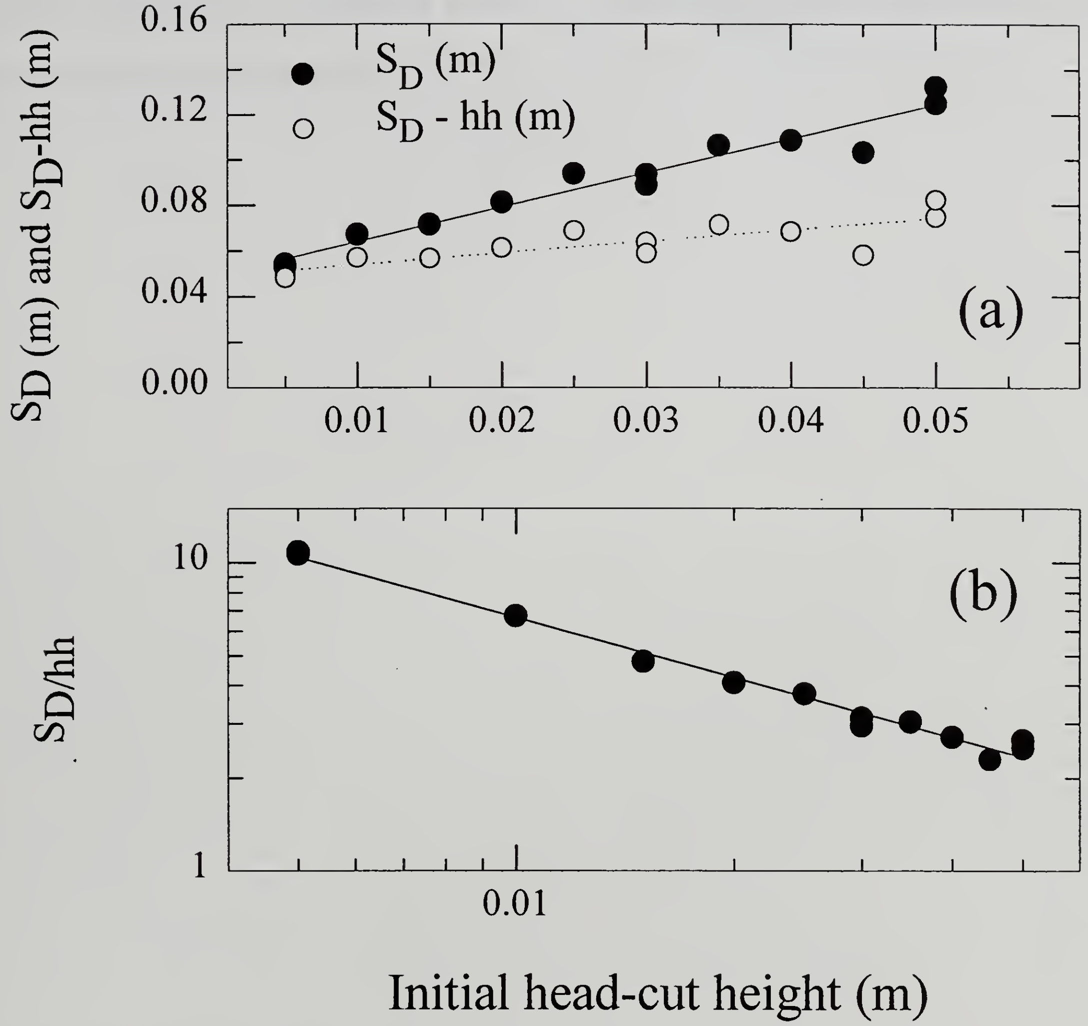
Examples of determining the time to steady state.



Example of time to steady state determination. (a) Scour depth criterion. (b) Sediment yield criterion. (c) Scour depth criterion. In (a) and (b) arrows indicate time to steady state; fitted curves and 10% deviation from asymptotic values are shown.

APPENDIX E:

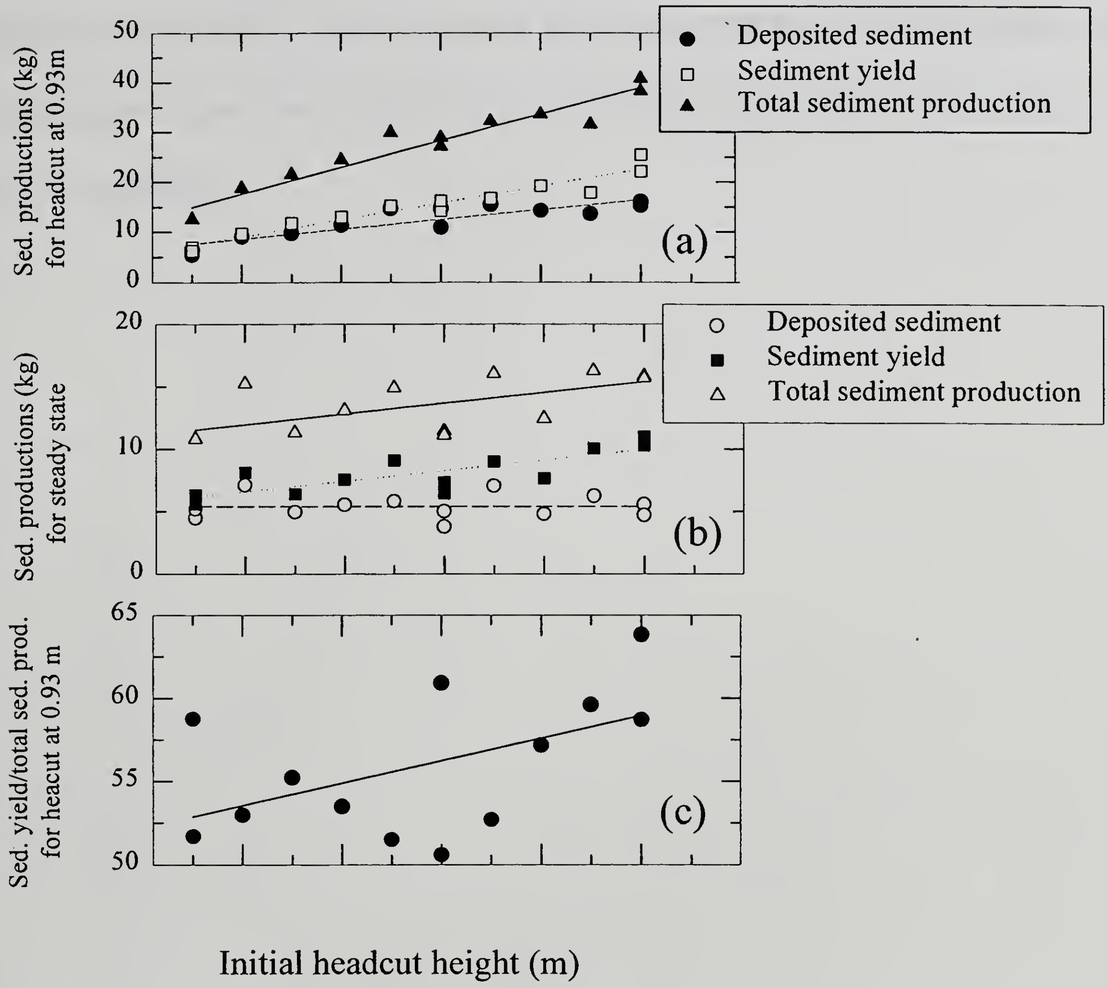
Time-averaged values of scour depth, scour depth minus initial headcut height, and the ratio of scour depth – to – initial headcut height as a function of headcut height.



Time-averaged values (steady state) of initial headcut height versus: (a) scour depth (r= 0.974, *PW*= 1.0) and scour depth minus initial headcut height (r=0.822; *PW*= 0.957); (b) ratio S_D/hh, scour depth/initial headcut height (r= 0.993; *PW*= 1.0). r is the correlation coefficient and *PW* is the probability that the regression correctly describes the relationship between initial headcut height and the dependent variable.

APPENDIX F:

Relationship between total sediment production at 0.93m, total sediment production for steady state, and the ratio of sediment yield – to – total sediment production at 0.93m as a function of initial headcut height.



(a) Relationship between sediment productions and headcut height (for total sediment production, *r*= 0.965; *PW*= 1.0); (b) relationship between sediment productions at the moment of steady state and headcut height (for total sediment production *R*= 0.612; *PW*= 0.615); (c) ratio sediment yield/total sediment production (*r*= 0.518; *PW*= .441). *r* is the correlation coefficient and *PW* is the probability that the regression correctly describes the relationship between initial headcut height and the dependent variable.

APPENDIX G:

Along flume profiles of the initial and final bed surface and the trace of the scour depth for the repeated experiments. (a) 0.005(1) and 0.005(2); (b) 0.030(1) and 0.030(2); 0.050(1) and 0.050(2).

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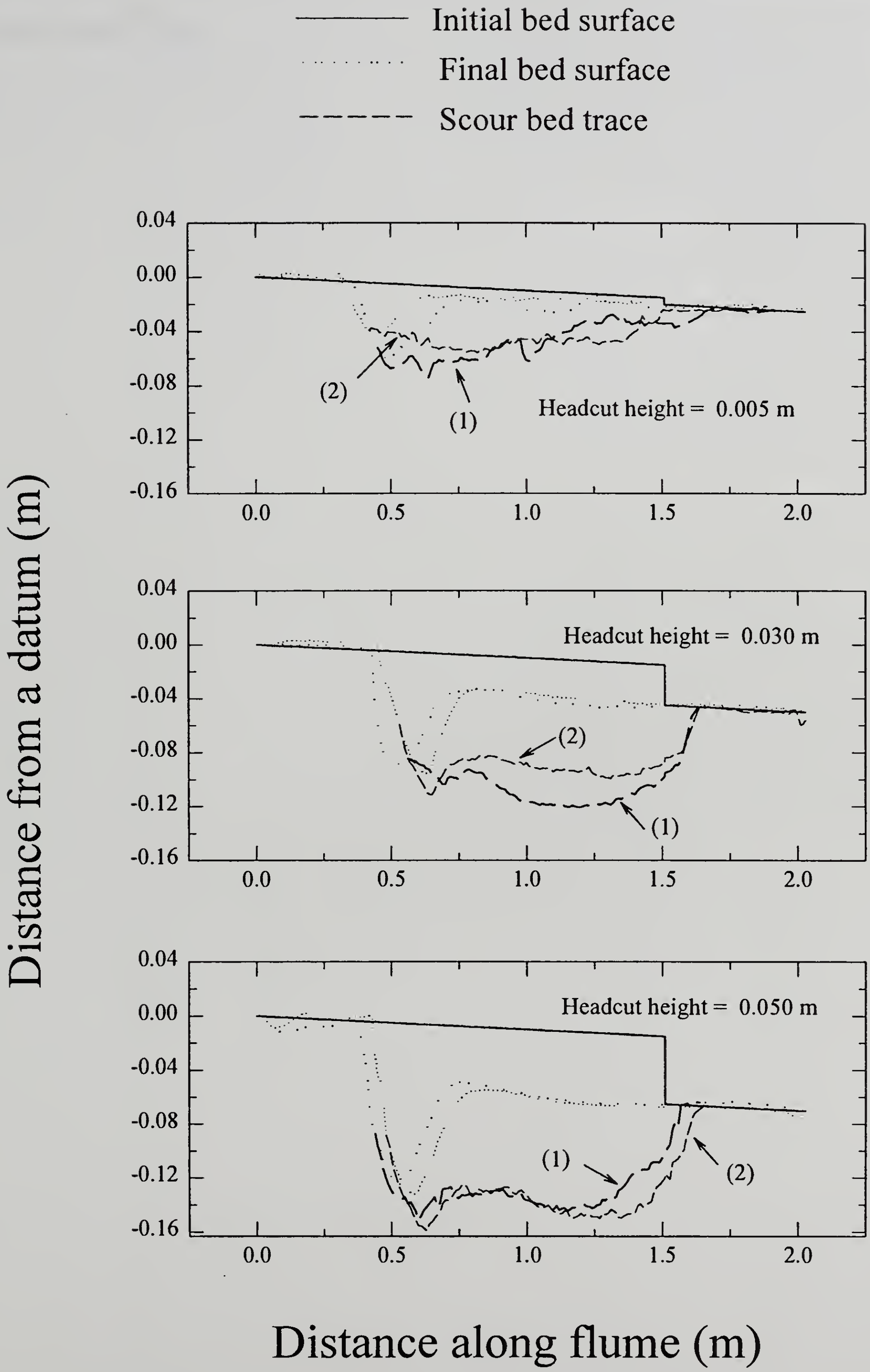

Along flume profiles of the initial and final bed surface and the trace of the scour depth for the repeated experiments. (a) 0.005(1) and 0.005(2); (b) 0.030(1) and 0.030(2); 0.050(1) and 0.050(2). Flow is from left to right.

APPENDIX H:

Time variation in runoff rate (mm h^{-1}) measured at the outflow during rainfall application for each experimental run.

Runoff Rates				
Run	Rainfall	Date	Time	Runoff Rate
(Initial headcut height)	(mm h^{-1})		(hr)	(mm h^{-1})
0.005(1)	26.70	11-Mar-1998	1.57	2.16
			2.00	12.00
			2.50	15.81
			3.00	16.87
			3.50	17.84
			4.00	18.20
			4.50	18.87
0.005(2)	26.70	27-Mar-1998	1.18	1.96
			1.50	3.65
			2.00	9.29
			2.50	14.35
			3.00	17.44
			3.50	17.47
			4.00	18.88
			4.50	19.82
0.010	26.70	5-Mar-1998	1.08	2.73
			1.50	4.33
			2.00	13.39
			2.50	16.75
			3.00	18.56
			3.50	19.43
			4.00	20.14
			4.50	21.26
0.015	26.70	20-Feb-1998	1.32	2.14
			1.50	5.75
			2.00	15.58
			2.50	18.62
			3.00	19.43
			3.50	20.04
			4.00	20.69
			4.50	21.20

0.020	26.70	10-Feb-1998	1.08	3.43
			1.50	12.40
			2.00	17.12
			2.50	18.99
			3.12	20.64
			3.50	21.39
			4.00	22.23
			4.50	22.53
0.025	21.20	12-Dec-1997	1.37	5.93
			2.00	13.73
			2.50	16.09
			3.00	17.06
			3.50	17.90
			4.00	18.38
			4.50	18.13
0.030(1)	21.20	19-Nov-1997	1.18	1.79
			1.55	5.44
			2.03	12.40
			2.55	14.38
			3.05	15.43
			3.53	16.24
			4.03	16.56
			4.50	17.04
0.030(2)	26.70	17-Mar-1998	1.33	2.27
			1.50	2.69
			2.00	13.43
			2.50	16.92
			3.00	18.59
			3.50	19.28
			4.00	20.82
			4.50	22.10
0.035	21.20	1-Dec-1997	0.85	0.91
			1.50	11.00
			2.00	14.91
			2.50	16.56
			3.00	17.37
			3.50	17.76
			4.00	18.22

			4.45	19.50
0.040	26.70	4-Feb-1998	1.00	1.80
			1.50	12.17
			2.00	16.52
			2.50	18.36
			3.00	19.30
			3.50	19.91
			4.00	20.45
			4.50	20.46
0.045	26.70	17-Feb-1998	1.03	3.08
			1.50	7.28
			2.00	15.18
			2.50	18.34
			3.00	19.59
			3.50	20.26
			4.00	20.80
			4.50	21.43
0.050(1)	26.70	26-Feb-1998	0.93	2.15
			1.50	7.30
			2.00	15.50
			2.50	17.77
			3.00	18.94
			3.50	20.02
			4.00	20.61
			4.50	21.50
0.050(2)	26.70	23-Mar-1998	1.33	1.45
			1.50	3.56
			2.00	11.61
			2.50	14.99
			3.00	17.28
			3.50	18.20
			4.00	19.29
			4.50	19.76

APPENDIX I:

Time variation in brinkpoint position, maximum scour depth (S_D), length-to-maximum-scour depth (S_L), S_l/S_D and entry angle of overfall jet for each experimental run.

Scour Hole Dimensions							
Run	Date	Time	Brinkpoint	S_D	S_L	S_l/S_D	Jet Angle
(Initial headcut height)		(s)	(m)	(m)	(m)		(degrees)
0.005(1)	11-Mar-1998	0	0.000	0.005	0.000	0.000	
		15	0.010	0.006	0.015	2.559	
		30	0.012	0.007	0.016	2.197	
		45	0.013	0.007	0.021	2.931	
		60	0.013	0.011	0.031	2.880	18.7
		75	0.017	0.015	0.041	2.822	18.1
		90	0.017	0.016	0.043	2.598	13.2
		105	0.018	0.017	0.043	2.536	24.6
		120	0.018	0.017	0.043	2.536	28.6
		135	0.018	0.017	0.043	2.536	
		150	0.018	0.017	0.043	2.536	21.8
		165	0.022	0.017	0.044	2.595	18.1
		180	0.023	0.013	0.042	3.336	19.9
		195	0.036	0.014	0.049	3.511	14.7
		225	0.043	0.017	0.038	2.297	12.1
		240	0.053	0.016	0.044	2.702	14.5
		255	0.060	0.015	0.050	3.234	13.6
		270	0.061	0.017	0.050	2.942	9.3
		285	0.065	0.015	0.050	3.378	7.6
		300	0.070	0.016	0.044	2.741	19.9
		315	0.083	0.015	0.043	2.779	24.6
		330	0.087	0.020	0.048	2.429	8.5
		345	0.089	0.020	0.045	2.311	20.6
		360	0.097	0.021	0.044	2.112	
		375	0.107	0.021	0.056	2.746	18.9
		390	0.117	0.021	0.053	2.493	6.4
		405	0.121	0.021	0.058	2.844	15.1
		435	0.138	0.024	0.042	1.721	13.1
		450	0.140	0.023	0.046	2.036	18.4
		465	0.146	0.024	0.040	1.682	26.1
		480	0.161	0.025	0.058	2.313	7.8
		495	0.168	0.022	0.045	2.032	21.3
		510	0.174	0.024	0.052	2.168	4.0
		525	0.183	0.025	0.063	2.526	6.8
		540	0.183	0.024	0.075	3.082	9.7
		555	0.187	0.027	0.046	1.689	16.7

		570	0.194	0.027	0.053	1.974	7.6
		585	0.206	0.031	0.043	1.410	11.3
		600	0.217	0.030	0.054	1.798	8.0
		615	0.221	0.027	0.071	2.632	18.0
		630	0.230	0.028	0.090	3.177	9.4
		645	0.239	0.028	0.058	2.082	3.4
		660	0.249	0.028	0.064	2.305	6.4
		675	0.259	0.027	0.077	2.888	12.9
		690	0.272	0.027	0.086	3.201	22.9
		705	0.277	0.028	0.077	2.764	12.1
		720	0.286	0.029	0.085	2.925	7.6
		735	0.288	0.029	0.083	2.885	7.2
		750	0.303	0.028	0.095	3.442	18.8
		765	0.308	0.029	0.070	2.430	13.1
		795	0.328	0.031	0.088	2.820	21.3
		810	0.334	0.034	0.084	2.455	14.5
		825	0.344	0.033	0.093	2.813	4.9
		840	0.348	0.032	0.094	2.913	8.5
		855	0.357	0.030	0.085	2.858	13.8
		870	0.365	0.029	0.089	3.031	12.1
		885	0.370	0.029	0.110	3.807	15.3
		900	0.377	0.028	0.071	2.554	17.7
		915	0.384	0.029	0.074	2.592	6.1
		930	0.384	0.027	0.079	2.966	22.8
		945	0.395	0.029	0.087	3.028	19.9
		960	0.398	0.031	0.086	2.820	15.9
		975	0.409	0.027	0.102	3.789	22.3
		990	0.417	0.028	0.123	4.428	25.2
		1005	0.428	0.029	0.142	4.993	13.1
		1020	0.439				14.9
		1035	0.458	0.018	0.048	2.716	18.9
		1050	0.466	0.024	0.051	2.133	29.5
		1065	0.482	0.032	0.069	2.172	22.9
		1080	0.493	0.031	0.073	2.352	18.9
		1095	0.504	0.031	0.082	2.689	21.4
		1110	0.521	0.034	0.082	2.445	22.3
		1140	0.532	0.035	0.089	2.584	29.5
		1155	0.537	0.037	0.082	2.223	8.9
		1170	0.546	0.036	0.093	2.593	
		1185	0.557	0.036	0.088	2.459	16.4
		1200	0.569	0.038	0.091	2.431	21.4
		1215	0.583	0.041	0.096	2.356	23.7

		1230	0.596	0.043	0.100	2.326	25.6
		1245	0.605	0.043	0.093	2.170	8.0
		1260	0.616	0.044	0.084	1.898	20.1
		1275	0.620	0.046	0.091	1.982	
		1290	0.632	0.048	0.098	2.053	10.6
		1305	0.642	0.048	0.104	2.169	12.7
		1335	0.654	0.038	0.089	2.313	20.1
		1350	0.662	0.044	0.082	1.870	30.7
		1365	0.668	0.044	0.094	2.127	27.4
		1380	0.678	0.046	0.083	1.825	14.8
		1395	0.682	0.047	0.101	2.154	25.9
		1410	0.695	0.044	0.090	2.018	33.3
		1425	0.695	0.048	0.083	1.719	5.7
		1440	0.695	0.048	0.083	1.719	14.0
		1455	0.702	0.048	0.086	1.769	18.1
		1470	0.719	0.041	0.081	1.980	25.0
		1485	0.728	0.045	0.081	1.788	32.6
		1500	0.742	0.050	0.075	1.516	34.1
		1515	0.750	0.051	0.079	1.541	23.7
		1530	0.764	0.051	0.081	1.591	28.3
		1545	0.773	0.053	0.084	1.586	38.6
		1560	0.778	0.055	0.068	1.230	14.5
		1575	0.785	0.054	0.079	1.479	11.9
		1620	0.805	0.054	0.093	1.733	31.1
		1635	0.821	0.049	0.087	1.767	27.2
		1650	0.834	0.056	0.077	1.367	22.0
		1665	0.845	0.059	0.110	1.868	41.9
		1680	0.858	0.051	0.086	1.681	34.7
		1695	0.866	0.056	0.091	1.629	23.4
		1725	0.888	0.053	0.087	1.642	31.3
		1740	0.894	0.055	0.081	1.473	25.2
		1755	0.911	0.055	0.082	1.500	22.5
		1770	0.918	0.055	0.089	1.620	19.2
		1785	0.932	0.049	0.083	1.703	41.9
		1800	0.941	0.053	0.088	1.677	23.3
		1815	0.954	0.052	0.094	1.807	37.5
		1830	0.963	0.052	0.100	1.916	33.7
		1845	0.973	0.052	0.103	1.973	32.2
		1860	0.982	0.056	0.097	1.746	30.0
		1875	0.985	0.055	0.098	1.765	40.0
		1890	0.998	0.058	0.093	1.606	52.1
		1905	1.015	0.056	0.098	1.737	37.9

		1920	1.019	0.055	0.094	1.699	11.5
		1935	1.030	0.055	0.110	1.986	31.9
		1950	1.041	0.051	0.100	1.965	24.1
		1965	1.046	0.053	0.100	1.902	28.3
		2025	1.072	0.051	0.088	1.726	44.1
		2040	1.084	0.051	0.083	1.644	32.7
		2055	1.085	0.055	0.085	1.546	31.2
		2070	1.110	0.055	0.101	1.814	31.1
		2085		0.057	0.085	1.497	20.6
		2100	1.126	0.055	0.089	1.625	27.1
		2115	1.135	0.057	0.102	1.801	10.4
		2130	1.140	0.053	0.113	2.120	35.8
0.005(2)	27-Mar-1998	0	0.000	0.005	0.000	0.000	
		15	0.005	0.004	0.007	1.614	
		30	0.011	0.008	0.017	2.122	21.3
		45	0.028	0.012	0.044	3.508	23.7
		60	0.037				22.4
		75	0.050	0.014	0.044	3.196	10.1
		90	0.065	0.017	0.044	2.627	15.6
		105	0.078	0.017	0.053	3.180	10.3
		120	0.091	0.017	0.075	4.473	24.1
		150	0.114				
		165	0.138	0.017	0.124	7.263	19.3
		180	0.154	0.017	0.145	8.480	22.0
		195	0.169	0.015	0.053	3.651	19.4
		210	0.183	0.018	0.063	3.492	13.7
		225	0.195	0.027	0.071	2.652	22.6
		240	0.214	0.032	0.078	2.439	34.9
		270	0.248	0.037	0.085	2.295	15.3
		285	0.264	0.039	0.098	2.521	12.9
		300	0.285	0.038	0.103	2.726	13.7
		315	0.299	0.038	0.091	2.419	11.8
		330	0.309	0.040	0.080	2.003	27.2
		345	0.331	0.042	0.092	2.208	35.8
		360	0.345	0.043	0.106	2.480	36.9
		375	0.361	0.046	0.098	2.128	17.2
		390	0.376	0.045	0.103	2.284	16.5
		405	0.392	0.037			18.4
		420	0.406	0.042	0.093	2.198	16.2
		435	0.417	0.044	0.098	2.229	23.6
		450	0.431	0.042	0.104	2.481	16.7

		480	0.441	0.046	0.095	2.054	20.9
		495	0.452	0.044	0.097	2.211	24.8
		510	0.473	0.040	0.103	2.575	34.0
		525	0.491	0.044	0.111	2.502	34.3
		555	0.516	0.047	0.118	2.487	18.6
		570	0.528	0.049	0.105	2.132	13.8
		585	0.528	0.048	0.105	2.208	11.9
		600	0.533	0.048	0.107	2.261	5.6
		615	0.546	0.044	0.097	2.227	26.8
		630	0.572	0.044	0.107	2.442	31.3
		645	0.588	0.044	0.109	2.482	23.6
		660	0.606	0.047	0.112	2.391	43.8
		675	0.618	0.046	0.108	2.359	49.7
		690	0.630	0.046	0.087	1.916	16.6
		705	0.646	0.043	0.082	1.916	
		720	0.661	0.046	0.086	1.862	19.6
		735	0.669	0.049	0.087	1.796	42.7
		750	0.689	0.050	0.090	1.800	34.5
		765	0.701	0.050	0.106	2.131	16.4
		780	0.711	0.048	0.084	1.739	34.9
		810	0.751	0.058	0.083	1.429	35.5
		825	0.766	0.053	0.084	1.583	38.2
		870	0.812	0.061	0.076	1.252	37.8
		885	0.827	0.059	0.080	1.363	25.1
		915	0.870	0.059	0.088	1.496	46.8
		930	0.882	0.057	0.079	1.384	33.9
		945	0.901	0.057	0.083	1.461	37.9
		960	0.913	0.054	0.079	1.463	42.7
		975	0.932	0.059	0.086	1.449	
		990	0.954	0.060	0.097	1.608	36.0
		1005	0.974	0.060	0.114	1.893	21.8
		1020	0.997	0.057	0.118	2.063	29.1
		1080	1.043	0.058	0.104	1.787	13.4
		1095	1.064	0.051	0.105	2.037	24.6
		1110	1.067	0.052	0.111	2.109	11.3
		1125	1.081	0.046	0.103	2.249	37.1
		1140	1.094	0.048	0.103	2.162	46.3
		1155	1.117	0.047	0.109	2.300	30.3
		1170	1.136	0.046	0.121	2.638	34.6
		1185	1.148	0.046	0.116	2.491	31.0
		1200	1.162	0.046	0.111	2.430	38.0
		1215	1.176	0.047	0.109	2.322	32.6

		1230	1.183	0.047	0.105	2.218	25.8
0.010	5-Mar-1998	0	0.000	0.010	0.000	0.000	
		15	0.000	0.013		0.000	34.0
		30	0.012	0.020	0.050	2.535	29.1
		45	0.038	0.026	0.055	2.121	25.1
		60	0.052	0.029	0.076	2.626	25.1
		75	0.060	0.032	0.081	2.514	28.0
		90	0.080	0.032	0.082	2.551	24.6
		105	0.088	0.037	0.085	2.324	21.0
		120	0.096	0.038	0.094	2.480	21.3
		135	0.105	0.043	0.091	2.090	27.4
		150	0.121	0.046	0.092	2.020	32.9
		165	0.125	0.048	0.099	2.058	33.1
		180	0.141	0.052	0.101	1.929	32.5
		195	0.160	0.051	0.103	2.018	39.8
		210	0.170	0.054	0.106	1.970	39.1
		225	0.186	0.056	0.108	1.939	37.0
		240	0.197	0.054	0.111	2.073	24.6
		255	0.210	0.059	0.107	1.829	38.9
		270	0.220	0.058	0.112	1.926	32.5
		285	0.235	0.055	0.102	1.860	41.6
		300	0.249	0.051	0.110	2.165	38.5
		315	0.262	0.056	0.093	1.660	35.5
		330	0.275	0.058	0.102	1.769	36.5
		345	0.284	0.059	0.093	1.563	23.2
		360	0.290	0.062	0.090	1.452	43.3
		375	0.311	0.061	0.113	1.860	43.7
		405	0.338	0.064	0.108	1.691	52.4
		420	0.346	0.062	0.102	1.641	
		435	0.365	0.062	0.105	1.695	31.0
		450	0.378	0.064	0.114	1.768	38.3
		465	0.397	0.066	0.112	1.706	29.6
		480	0.409	0.064	0.116	1.821	22.8
		495	0.416	0.063	0.108	1.707	40.5
		510	0.431	0.063	0.117	1.853	30.1
		540	0.456	0.065	0.115	1.766	44.1
		555	0.466	0.067	0.115	1.710	42.8
		570	0.484	0.066	0.123	1.845	36.9
		585	0.502	0.063	0.131	2.096	39.3
		600	0.510	0.064	0.122	1.908	36.8
		615	0.518	0.065	0.114	1.745	38.4

		630	0.528	0.067	0.118	1.768	37.8
		645	0.536	0.068	0.118	1.742	40.5
		675	0.570	0.064	0.132	2.067	43.0
		690	0.584	0.065	0.119	1.839	36.7
		705	0.599	0.066	0.123	1.864	47.2
		720	0.616	0.069	0.124	1.795	49.2
		735	0.623	0.070	0.111	1.583	39.1
		750	0.628	0.066	0.121	1.826	39.4
		765	0.645	0.066	0.118	1.787	48.4
		780	0.654	0.068	0.120	1.781	44.0
		795	0.667	0.067	0.123	1.841	32.5
		810	0.676	0.067	0.110	1.637	46.7
		840	0.700	0.070	0.115	1.649	44.4
		855	0.712	0.071	0.125	1.752	42.2
		870	0.718	0.070	0.104	1.499	21.8
		885	0.726	0.070	0.096	1.369	44.0
		900	0.740	0.067	0.096	1.426	42.9
		915	0.750	0.068	0.103	1.502	39.2
		930	0.768	0.072	0.105	1.449	38.8
		945	0.780	0.068	0.109	1.603	47.5
		990	0.824	0.065	0.120	1.844	46.1
		1005	0.836	0.067	0.108	1.609	43.5
		1020	0.848	0.067	0.117	1.739	39.3
		1035	0.856	0.069	0.116	1.693	39.3
		1050	0.870	0.065	0.112	1.719	39.3
		1065	0.886	0.063	0.114	1.819	40.1
		1080	0.903	0.058	0.113	1.955	35.6
		1095	0.913	0.049	0.094	1.893	33.7
		1110	0.931				19.4
		1125	0.956				15.0
		1140	0.975				39.6
		1155	0.990	0.042	0.070	1.680	30.7
		1170	1.012	0.043	0.083	1.921	25.2
		1185	1.043	0.049	0.084	1.709	33.3
		1200	1.065	0.051	0.093	1.826	39.5
		1215	1.080	0.058	0.096	1.659	54.2
		1230	1.101	0.051	0.109	2.127	46.2
		1275	1.160	0.058	0.124	2.147	49.6
0.015	20-Feb-1998	0	0.000	0.015	0.000	0.000	
		15	0.021	0.021	0.035	1.722	49.1
		30	0.021	0.023	0.053	2.356	40.2

		45	0.024	0.034	0.069	2.003	36.4
		60	0.032	0.037	0.060	1.598	39.5
		75	0.045	0.043	0.081	1.883	34.8
		105	0.063	0.052	0.088	1.711	20.9
		120	0.076	0.052	0.095	1.833	45.0
		135	0.085	0.058	0.084	1.455	46.3
		150	0.097	0.056	0.094	1.684	46.2
		165	0.106	0.057	0.094	1.643	34.8
		180	0.114	0.057	0.096	1.701	51.0
		210	0.139	0.059	0.092	1.558	45.6
		225	0.149	0.064	0.091	1.407	43.4
		255	0.182	0.070	0.095	1.362	45.5
		270	0.196	0.072	0.104	1.452	24.5
		285	0.204	0.073	0.096	1.308	47.6
		300	0.223	0.072	0.103	1.441	31.7
		315	0.234	0.071	0.095	1.349	40.1
		330	0.244	0.067	0.102	1.516	40.1
		345	0.262	0.066	0.102	1.557	46.9
		360	0.278	0.067	0.098	1.469	41.2
		375	0.298	0.068	0.092	1.369	50.4
		390	0.308	0.070	0.095	1.357	42.0
		405	0.318	0.071	0.094	1.321	37.2
		420		0.066	0.102	1.532	47.5
		435	0.356	0.069	0.102	1.486	53.9
		450	0.369	0.068	0.086	1.268	39.5
		465	0.386	0.073	0.091	1.255	50.9
		480	0.398	0.073	0.098	1.341	58.2
		495	0.410	0.072	0.096	1.326	45.9
		525	0.439	0.068	0.093	1.366	40.8
		540	0.455	0.067	0.082	1.232	52.2
		555	0.467	0.067	0.088	1.326	42.2
		570	0.483	0.068	0.085	1.245	45.0
		585	0.491	0.068	0.083	1.223	30.3
		600	0.502	0.064	0.084	1.315	50.7
		615	0.521	0.065	0.093	1.432	29.4
		630	0.527	0.068	0.082	1.217	50.8
		645	0.541	0.072	0.086	1.189	37.9
		675	0.573	0.074	0.082	1.109	43.2
		690	0.592	0.075	0.088	1.184	60.3
		720	0.621	0.072	0.082	1.139	37.4
		735	0.636	0.072	0.080	1.114	51.2
		750	0.651	0.074	0.082	1.111	53.3

		765	0.662	0.070	0.075	1.070	42.0
		780	0.676	0.072	0.082	1.141	34.6
		795	0.692	0.070	0.089	1.266	44.0
		810	0.702	0.073	0.076	1.044	42.8
		840	0.734	0.075	0.087	1.165	51.6
		855	0.745	0.076	0.093	1.223	32.6
		870	0.763	0.072	0.087	1.202	44.4
		885	0.777	0.070	0.080	1.134	48.2
		900	0.790	0.076	0.083	1.082	41.6
		930		0.078	0.089	1.133	45.8
		945	0.829	0.073	0.082	1.124	51.7
		960	0.845	0.073	0.097	1.337	36.5
		975	0.861	0.072	0.083	1.153	57.0
		990	0.882	0.074	0.088	1.185	53.4
		1005	0.894	0.072	0.076	1.057	62.2
		1020	0.912	0.071	0.082	1.167	39.6
		1035	0.928	0.077	0.086	1.124	42.5
0.020	10-Feb-1998	0	0.000	0.020	0.000	0.000	
		15	0.019	0.029	0.040	1.375	42.1
		30	0.035	0.035	0.070	2.026	46.3
		45	0.045	0.042	0.074	1.749	33.7
		60	0.053	0.051	0.086	1.709	26.6
		75	0.057				41.6
		90	0.068	0.057	0.088	1.554	34.1
		105					
		120	0.087	0.059	0.083	1.403	54.8
		135	0.102	0.065	0.089	1.370	52.3
		150	0.115	0.069	0.089	1.296	51.3
		165	0.127	0.068	0.094	1.393	45.0
		180	0.135	0.073	0.127	1.751	51.7
		195	0.150	0.072	0.091	1.259	45.0
		210	0.165	0.073	0.087	1.186	40.7
		225					
		240	0.191	0.080	0.096	1.194	45.8
		255	0.208	0.076	0.106	1.393	44.0
		270	0.215	0.079	0.082	1.034	37.9
		285	0.231	0.082	0.094	1.144	47.0
		300	0.242	0.079	0.090	1.134	46.1
		315	0.254	0.079	0.082	1.039	52.4
		330	0.272	0.077	0.082	1.058	47.7
		345	0.288	0.078	0.083	1.075	46.5

		360	0.303	0.076	0.088	1.158	44.3
		375	0.313	0.076	0.087	1.142	42.4
		390	0.323	0.082	0.092	1.122	35.5
		435	0.363	0.079	0.093	1.170	54.8
		450	0.380	0.081	0.100	1.228	50.4
		465	0.393	0.080	0.100	1.247	36.9
		480	0.402	0.078	0.090	1.152	27.8
		495	0.410	0.088	0.090	1.025	37.3
		525	0.437	0.080	0.095	1.193	52.0
		540	0.448	0.080	0.090	1.123	52.4
		555	0.470	0.082			51.8
		570	0.484	0.076	0.088	1.154	50.8
		585	0.493	0.083	0.082	0.983	29.1
		600	0.501	0.080	0.088	1.095	45.0
		615	0.509	0.080	0.088	1.112	47.9
		630	0.520	0.082	0.092	1.120	61.6
		665	0.550	0.087	0.092	1.049	46.3
		675	0.566				56.3
		695	0.579	0.087	0.094	1.083	42.7
		705	0.594	0.083	0.100	1.200	17.4
		720	0.609				60.1
		735	0.616				45.0
		750	0.627	0.076	0.088	1.158	39.8
		765	0.637	0.081	0.090	1.111	32.0
		780	0.648	0.083	0.085	1.022	45.0
		795		0.081	0.090	1.111	38.7
		810	0.672	0.086	0.103	1.198	46.0
		840	0.695	0.079	0.075	0.949	39.4
		855	0.706	0.080	0.066	0.823	49.0
		870	0.719	0.079	0.073	0.927	45.0
		885	0.731	0.079	0.060	0.753	43.5
		900	0.746	0.081	0.087	1.065	41.4
		915		0.079	0.098	1.248	47.4
		945	0.779	0.084	0.081	0.970	43.0
		960	0.791	0.085	0.076	0.891	59.0
		975	0.805	0.085	0.097	1.132	38.8
		990	0.818	0.085	0.092	1.080	45.9
		1005	0.833	0.085	0.083	0.977	44.2
		1020		0.085	0.089	1.057	48.2
		1050	0.876	0.081	0.098	1.205	47.6
		1065	0.887	0.076	0.071	0.943	51.1
		1080	0.902	0.077	0.084	1.086	49.4

		1095	0.912	0.078	0.070	0.897	53.1
		1110	0.928	0.084	0.080	0.952	56.3
0.025	12-Dec-1997	0	0.000	0.025	0.000	0.000	
		15	0.019	0.029	0.040	1.375	42.1
		30	0.035	0.035	0.070	2.026	46.3
		45	0.045	0.042	0.074	1.749	33.7
		60	0.053	0.051	0.086	1.709	26.6
		75	0.057				41.6
		90	0.068	0.057	0.088	1.554	34.1
		120	0.087	0.059	0.083	1.403	54.8
		135	0.102	0.065	0.089	1.370	52.3
		150	0.115	0.069	0.089	1.296	51.3
		165	0.127	0.068	0.094	1.393	45.0
		180	0.135	0.073	0.127	1.751	51.7
		195	0.150	0.072	0.091	1.259	45.0
		210	0.165	0.073	0.087	1.186	40.7
		240	0.191	0.080	0.096	1.194	45.8
		255	0.208	0.076	0.106	1.393	44.0
		270	0.215	0.079	0.082	1.034	37.9
		285	0.231	0.082	0.094	1.144	47.0
		300	0.242	0.079	0.090	1.134	46.1
		315	0.254	0.079	0.082	1.039	52.4
		330	0.272	0.077	0.082	1.058	47.7
		345	0.288	0.078	0.083	1.075	46.5
		360	0.303	0.076	0.088	1.158	44.3
		375	0.313	0.076	0.087	1.142	42.4
		390	0.323	0.082	0.092	1.122	35.5
		435	0.363	0.079	0.093	1.170	54.8
		450	0.380	0.081	0.100	1.228	50.4
		465	0.393	0.080	0.100	1.247	36.9
		480	0.402	0.078	0.090	1.152	27.8
		495	0.410	0.088	0.090	1.025	37.3
		525	0.437	0.080	0.095	1.193	52.0
		540	0.448	0.080	0.090	1.123	52.4
		555	0.470	0.082			51.8
		570	0.484	0.076	0.088	1.154	50.8
		585	0.493	0.083	0.082	0.983	29.1
		600	0.501	0.080	0.088	1.095	45.0
		615	0.509	0.080	0.088	1.112	47.9
		630	0.520	0.082	0.092	1.120	61.6
		665	0.550	0.087	0.092	1.049	46.3

		675	0.566				56.3
		695	0.579	0.087	0.094	1.083	42.7
		705	0.594	0.083	0.100	1.200	17.4
		720	0.609				60.1
		735	0.616				45.0
		750	0.627	0.076	0.088	1.158	39.8
		765	0.637	0.081	0.090	1.111	32.0
		780	0.648	0.083	0.085	1.022	45.0
		795		0.081	0.090	1.111	38.7
		810	0.672	0.086	0.103	1.198	46.0
		840	0.695	0.079	0.075	0.949	39.4
		855	0.706	0.080	0.066	0.823	49.0
		870	0.719	0.079	0.073	0.927	45.0
		885	0.731	0.079	0.060	0.753	43.5
		900	0.746	0.081	0.087	1.065	41.4
		915		0.079	0.098	1.248	47.4
		945	0.779	0.084	0.081	0.970	43.0
		960	0.791	0.085	0.076	0.891	59.0
		975	0.805	0.085	0.097	1.132	38.8
		990	0.818	0.085	0.092	1.080	45.9
		1005	0.833	0.085	0.083	0.977	44.2
		1020		0.085	0.089	1.057	48.2
		1050	0.876	0.081	0.098	1.205	47.6
		1065	0.887	0.076	0.071	0.943	51.1
		1080	0.902	0.077	0.084	1.086	49.4
		1095	0.912	0.078	0.070	0.897	53.1
		1110	0.928	0.084	0.080	0.952	56.3
0.030(1)	19-Nov-1997	0	0.000	0.030	0.000	0.000	
		15	0.011	0.046	0.039	0.843	44.0
		30	0.037	0.061	0.071	1.175	57.4
		45	0.048	0.066	0.067	1.008	44.0
		60	0.060	0.075	0.068	0.900	55.3
		75	0.089	0.079	0.078	0.986	47.7
		135	0.194	0.087	0.058	0.665	52.8
		150	0.227	0.091	0.070	0.771	53.1
		165	0.249	0.094	0.079	0.845	60.6
		180	0.270	0.096	0.081	0.842	45.0
		195	0.296	0.095	0.084	0.889	50.7
		210	0.315	0.095	0.071	0.748	49.5
		225	0.342	0.097	0.071	0.730	60.5
		240	0.362	0.099	0.079	0.792	55.9

		255	0.384	0.102	0.075	0.736	52.5
		270	0.407	0.101	0.074	0.732	54.5
		285	0.423	0.101	0.068	0.680	53.8
		300	0.442	0.101	0.070	0.690	48.4
		330	0.487	0.099	0.073	0.737	46.5
		345	0.505	0.099	0.069	0.696	55.1
		360	0.527	0.101	0.071	0.701	56.3
		375	0.545	0.099	0.071	0.723	63.4
		390	0.570	0.105	0.069	0.653	51:1
		405	0.592	0.104	0.078	0.748	43.9
		420	0.610	0.099	0.068	0.690	51.8
		435	0.633	0.099	0.083	0.840	45.0
		450	0.650	0.098	0.086	0.882	57.7
		465	0.670	0.094	0.078	0.830	52.4
		480	0.689	0.097	0.072	0.741	44.2
		495	0.709	0.094	0.079	0.849	46.5
		510	0.735	0.096	0.088	0.916	48.4
		525	0.755	0.088	0.093	1.052	39.5
		540	0.778	0.089	0.092	1.030	48.7
		555	0.796	0.088	0.087	0.986	48.3
		570	0.819	0.084	0.085	1.016	43.0
		585	0.839	0.085	0.086	1.008	55.6
		600	0.860	0.088	0.086	0.977	45.9
		615	0.880	0.082	0.071	0.871	49.4
		630	0.904	0.082	0.067	0.815	39.8
		645	0.926	0.084	0.078	0.923	46.7
		660	0.949	0.088	0.085	0.963	55.0
		675	0.966	0.089	0.089	1.000	48.0
		690	0.985	0.087	0.091	1.045	54.5
		705	1.005	0.088	0.082	0.928	37.2
		720	1.027	0.087	0.082	0.948	45.0
0.030(2)	17-Mar-1998	0	0.000	0.030	0.000	0.000	
		15	0.000	0.030	0.045	1.467	59.0
		30	0.024	0.056	0.064	1.147	54.7
		45	0.040	0.065	0.062	0.951	44.7
		60	0.067	0.069	0.077	1.122	48.5
		75	0.097	0.070	0.085	1.200	54.5
		90	0.122	0.069	0.092	1.333	60.9
		105	0.148	0.074	0.102	1.378	56.3
		120	0.170	0.080	0.094	1.172	57.9
		135	0.194	0.082	0.100	1.208	54.5

		150	0.218	0.082	0.088	1.073	57.9
		165	0.244	0.083	0.098	1.176	59.5
		180	0.272	0.084	0.086	1.023	59.5
		195	0.295	0.088	0.093	1.056	59.5
		210	0.317	0.087	0.082	0.944	54.4
		225	0.345	0.088	0.086	0.977	75.2
		240	0.387	0.085	0.101	1.188	59.5
		255	0.415	0.085	0.089	1.047	63.4
		270	0.445	0.087	0.085	0.977	60.9
		285		0.088			62.2
		300	0.497	0.086	0.091	1.058	57.9
		315	0.520	0.088	0.083	0.943	54.4
		330	0.543	0.087	0.084	0.966	64.5
		345	0.574	0.089	0.093	1.040	68.1
		360	0.598	0.089	0.096	1.085	66.5
		375	0.620	0.088	0.088	1.000	57.9
		405	0.664	0.086	0.092	1.078	54.4
		420	0.682	0.088	0.084	0.958	54.4
		435	0.705	0.084	0.088	1.052	56.3
		465	0.741	0.090	0.084	0.925	59.5
		480	0.768	0.090	0.083	0.921	57.9
		495	0.790	0.090	0.080	0.893	69.6
		510	0.805	0.090	0.067	0.744	59.5
		525	0.822	0.093	0.090	0.970	56.3
		540	0.843	0.089	0.090	1.004	60.9
		555	0.866	0.086	0.085	0.990	63.4
		570					64.5
		585	0.911	0.091	0.085	0.930	65.5
		600	0.934	0.090	0.082	0.909	62.2
		615	0.952	0.093	0.096	1.031	66.5
		630	0.969	0.093	0.087	0.941	62.2
		645					
		660	1.009	0.094	0.099	1.055	60.9
0.035	1-Dec-1997	0	0.000	0.035	0.000	0.000	
		15	0.018	0.040	0.038	0.958	48.8
		30	0.038	0.058	0.066	1.144	54.2
		45	0.060	0.063	0.091	1.444	49.5
		60	0.082	0.072	0.067	0.926	45.9
		75	0.098	0.072	0.073	1.015	62.2
		90	0.099	0.088	0.084	0.954	45.0
		105	0.113	0.087	0.090	1.032	50.1

		120	0.142	0.090	0.090	1.000	52.4
		135	0.157	0.091	0.087	0.960	47.7
		150	0.177	0.094	0.081	0.863	45.0
		165	0.194	0.097	0.079	0.812	60.9
		180	0.214	0.095	0.080	0.841	65.5
		195	0.225	0.098	0.077	0.789	60.9
		210	0.243	0.101	0.077	0.763	65.5
		225	0.263	0.105	0.079	0.750	62.2
		240	0.279	0.105	0.073	0.693	60.9
		255	0.295	0.103	0.069	0.671	59.5
		270	0.314	0.108	0.075	0.692	56.3
		285	0.327	0.101	0.066	0.657	57.9
		300	0.351	0.104	0.072	0.689	62.2
		315	0.363	0.104	0.063	0.612	60.9
		330	0.386	0.104	0.063	0.604	57.9
		345	0.402	0.104	0.070	0.671	62.2
		360	0.421	0.103	0.067	0.653	54.4
		375	0.442	0.103	0.078	0.762	67.3
		390	0.459	0.104	0.064	0.621	57.9
		405	0.474	0.101	0.064	0.639	67.3
		420	0.489	0.103	0.070	0.680	67.3
		435	0.505	0.104	0.070	0.671	63.4
		450	0.522	0.108	0.077	0.715	59.5
		465	0.538	0.109	0.074	0.678	64.5
		480	0.549	0.109	0.071	0.649	63.4
		495	0.567	0.111	0.067	0.602	60.9
		510	0.579	0.111	0.068	0.612	62.2
		525	0.598	0.113	0.064	0.568	56.3
		540	0.614	0.109	0.073	0.666	68.9
		555	0.630	0.111	0.071	0.637	62.2
		570	0.641	0.110	0.068	0.616	73.6
		585	0.661	0.110	0.077	0.700	65.5
		600	0.681	0.108	0.075	0.697	66.5
		615	0.695	0.109	0.071	0.654	57.9
		630	0.710	0.108	0.075	0.697	65.5
		645	0.725	0.107	0.072	0.671	65.5
		660	0.737	0.108	0.078	0.723	47.7
		675	0.753	0.105	0.064	0.613	56.3
		695	0.774	0.103	0.076	0.734	
		705	0.779	0.109	0.070	0.645	59.5
		720	0.791	0.110	0.070	0.641	65.5
		735	0.804	0.106	0.068	0.643	64.5

		750	0.819	0.106	0.078	0.741	68.1
		765	0.837	0.103	0.069	0.671	63.4
		780	0.850	0.103	0.070	0.680	65.5
		810	0.882	0.103	0.068	0.662	63.4
		825	0.895	0.103	0.068	0.658	57.9
		840	0.910	0.105	0.069	0.657	59.5
		855	0.925	0.108	0.073	0.676	56.3
		870	0.940	0.108	0.071	0.658	71.5
		885	0.960	0.104	0.072	0.694	60.9
0.040	4-Feb-1998	0	0.000	0.040	0.000	0.000	
		15	0.027	0.050	0.059	1.189	53.8
		30	0.037	0.063	0.067	1.055	50.8
		45	0.047	0.074	0.077	1.052	52.7
		60	0.063	0.084	0.069	0.821	53.7
		75	0.077	0.083	0.078	0.935	55.9
		90	0.100	0.089	0.089	1.065	60.1
		105	0.120	0.094	0.085	0.955	57.9
		120	0.140	0.096	0.088	0.935	59.5
		135	0.167	0.096	0.089	0.922	60.9
		150	0.190	0.099	0.085	0.885	62.2
		165	0.211	0.098	0.087	0.875	56.3
		180	0.231	0.100	0.094	0.956	65.5
		195	0.250	0.103	0.085	0.846	52.4
		210	0.273	0.103	0.087	0.850	67.3
		225	0.291	0.101	0.076	0.747	62.2
		240	0.312	0.110	0.081	0.735	68.9
		255	0.334	0.107	0.088	0.825	60.9
		270	0.353	0.105	0.087	0.833	53.4
		285	0.374	0.100	0.085	0.848	60.9
		300	0.396	0.099	0.078	0.791	60.9
		315	0.416	0.101	0.083	0.814	67.3
		330	0.436	0.099	0.078	0.787	63.4
		345	0.452	0.101	0.074	0.736	62.2
		360	0.471	0.097	0.084	0.866	62.2
		375	0.484	0.101	0.073	0.723	56.3
		390	0.501	0.101	0.088	0.865	54.5
		405	0.523	0.103	0.088	0.857	60.9
		420	0.539	0.105	0.092	0.880	59.5
		435	0.560	0.103	0.093	0.908	64.5
		450	0.577	0.108	0.082	0.766	62.2
		465	0.590	0.105	0.082	0.782	57.9

		480	0.618	0.110	0.089	0.809	59.5
		495	0.626	0.112	0.096	0.860	60.9
		510	0.637	0.113	0.094	0.832	67.3
		525	0.656	0.108	0.092	0.845	60.9
		540	0.670	0.108	0.091	0.843	60.9
		555	0.687	0.109	0.094	0.857	59.5
		570	0.702	0.110	0.097	0.880	
		585	0.718	0.111	0.099	0.899	
		600	0.737	0.109	0.099	0.904	62.2
		630	0.767	0.116	0.092	0.791	57.9
		645	0.785	0.115	0.094	0.817	59.5
		665	0.801	0.116	0.090	0.777	61.1
		675	0.814	0.118	0.094	0.798	59.5
		695	0.831	0.113	0.098	0.865	63.4
		705	0.843	0.113	0.095	0.837	59.5
		720	0.862	0.118	0.093	0.784	63.4
		735	0.878	0.115	0.090	0.783	67.3
		750	0.897	0.111	0.091	0.820	66.5
		765	0.908	0.109	0.093	0.854	62.2
		780	0.922	0.109	0.100	0.914	68.9
		795	0.936	0.114	0.106	0.933	71.5
		810	0.953	0.112	0.104	0.926	60.9
		825	0.976	0.112	0.098	0.871	68.1
		840	0.989	0.118	0.092	0.778	66.5
0.045	17-Feb-1998	0	0.000	0.045	0.000	0.000	
		15	0.019	0.058	0.039	0.674	58.3
		30	0.045	0.080	0.061	0.764	58.2
		45	0.074	0.088	0.070	0.805	66.4
		60	0.100	0.090	0.076	0.844	64.5
		75	0.135	0.094	0.081	0.863	62.2
		90	0.169	0.097	0.087	0.895	60.9
		105	0.201	0.097	0.080	0.830	67.3
		120					69.6
		135	0.250	0.100	0.079	0.798	67.3
		150	0.279	0.098	0.075	0.773	68.9
		165	0.306	0.103	0.071	0.697	72.6
		180	0.331	0.105	0.079	0.748	73.1
		195	0.355	0.105	0.068	0.654	69.6
		225	0.410	0.107	0.083	0.776	70.9
		240	0.432	0.109	0.074	0.682	72.1
		255	0.455	0.107	0.079	0.739	66.5

		270	0.472	0.102	0.071	0.693	70.3
		285					62.2
		300	0.525	0.104	0.085	0.824	66.5
		315	0.548	0.103	0.080	0.771	63.4
		330	0.571	0.104	0.083	0.796	59.5
		345	0.595	0.105	0.080	0.765	59.5
		360	0.621	0.107	0.087	0.815	72.1
		375	0.642	0.105	0.084	0.801	66.9
		390	0.660	0.105	0.084	0.801	72.1
		405	0.685	0.104	0.084	0.811	66.5
		420	0.714	0.101	0.088	0.878	65.5
		435	0.736	0.099	0.093	0.937	64.5
		450	0.757	0.106	0.093	0.882	72.1
		465	0.777	0.101	0.082	0.808	74.4
		495	0.821	0.101	0.094	0.937	69.6
		510	0.846	0.103	0.093	0.897	68.1
		525	0.865	0.101	0.086	0.852	81.1
		540	0.884	0.100	0.081	0.812	66.5
		555	0.907	0.101	0.086	0.850	72.1
		570	0.934	0.107	0.098	0.919	75.2
		600	0.974	0.108	0.082	0.760	60.9
		615		0.103			69.6
		660	1.059	0.104	0.088	0.850	73.6
0.050(1)	26-Feb-1998	0	0.000	0.050	0.000	0.000	
		15	0.027	0.067	0.026	0.386	76.6
		30	0.056	0.086	0.072	0.841	76.9
		45	0.087	0.086	0.076	0.884	72.8
		60	0.108	0.092	0.081	0.876	69.6
		75					79.5
		90	0.169	0.102	0.083	0.813	70.3
		105	0.189	0.110	0.077	0.698	79.6
		120	0.210	0.114	0.084	0.739	67.3
		135	0.230	0.114	0.080	0.700	72.1
		150	0.248	0.116	0.082	0.707	75.6
		165	0.268	0.118	0.085	0.720	75.9
		180					80.5
		195	0.305	0.119	0.078	0.654	73.1
		210	0.322	0.126	0.085	0.673	83.2
		225	0.334	0.125	0.087	0.698	79.8
		240	0.362	0.123	0.085	0.692	79.6
		255	0.379	0.122	0.078	0.634	72.6

		270	0.395	0.122	0.084	0.689	75.6
		285	0.409	0.124	0.079	0.638	74.0
		300	0.426	0.125	0.082	0.656	75.2
		315	0.449	0.126	0.091	0.720	77.4
		330	0.469	0.121	0.090	0.743	72.1
		345	0.487	0.121	0.088	0.732	74.8
		360	0.513	0.125	0.097	0.773	82.4
		375	0.531	0.126	0.096	0.763	76.2
		390	0.550	0.127	0.104	0.816	74.0
		405	0.572	0.125	0.090	0.715	73.6
		420	0.584	0.122	0.089	0.727	74.4
		435	0.614	0.116	0.088	0.753	85.0
		450	0.627	0.119	0.083	0.703	80.6
		465	0.647	0.124	0.088	0.711	76.2
		480	0.664	0.123	0.083	0.673	75.9
		495	0.683	0.124	0.073	0.583	71.5
		510	0.699	0.122	0.076	0.619	72.1
		525	0.715	0.121	0.079	0.649	75.9
		540	0.730	0.127	0.082	0.645	64.5
		555					68.9
		570	0.771	0.128	0.086	0.674	64.5
		585	0.784	0.128	0.087	0.677	66.5
		600	0.805	0.131	0.086	0.660	68.9
		615	0.819	0.131	0.088	0.669	72.1
		630	0.838	0.132	0.091	0.693	69.6
		645	0.853	0.129	0.088	0.683	73.6
		660	0.874	0.127	0.075	0.587	77.4
		675	0.897	0.125	0.085	0.677	72.1
		690					75.9
		705	0.934	0.128	0.092	0.714	76.9
		720	0.951	0.131	0.087	0.660	76.6
		735	0.987	0.131	0.100	0.766	78.4
		750	1.006	0.133	0.099	0.745	79.3
		765	1.023	0.125	0.094	0.753	81.8
		795	1.067	0.119	0.094	0.793	83.2
		810	1.090	0.118	0.095	0.804	85.2
0.050(2)	23-Mar-1998	0	0.000	0.050	0.000	0.000	
		15	0.019	0.066	0.047	0.707	
		30					80.6
		45	0.064	0.090	0.069	0.770	85.9
		60	0.088	0.094	0.066	0.706	85.0

		75	0.107	0.103	0.068	0.663	81.8
		90	0.118	0.108	0.071	0.655	83.5
		105	0.132	0.117	0.076	0.650	86.0
		120	0.146	0.118	0.074	0.631	75.6
		135	0.162	0.123	0.081	0.656	73.1
		150	0.171	0.127	0.063	0.498	72.6
		165	0.187	0.126	0.068	0.536	74.0
		180	0.202	0.126	0.077	0.608	67.3
		195	0.222	0.129	0.078	0.606	83.6
		210	0.233	0.132	0.073	0.553	77.4
		225	0.250	0.129	0.071	0.552	74.4
		240	0.268	0.131	0.076	0.579	72.6
		255	0.284	0.132	0.076	0.577	73.1
		270	0.291	0.129	0.072	0.559	70.9
		285	0.307	0.128	0.075	0.588	75.2
		300	0.324	0.131	0.073	0.557	72.1
		315	0.337	0.134	0.069	0.516	71.5
		330	0.354	0.132	0.077	0.583	63.4
		345	0.368	0.133	0.080	0.599	66.5
		360	0.382	0.135	0.080	0.592	65.5
		375	0.394	0.138	0.078	0.565	68.9
		390	0.412	0.136	0.079	0.580	73.6
		405	0.422	0.137	0.079	0.579	72.1
		420	0.445	0.136	0.073	0.535	77.7
		450	0.468	0.132	0.082	0.625	62.2
		465	0.481	0.135	0.090	0.667	72.1
		480	0.490	0.133	0.087	0.656	68.1
		495	0.505	0.133	0.071	0.535	67.3
		510	0.519	0.135	0.079	0.586	76.9
		525	0.533	0.135	0.080	0.595	74.0
		540	0.553	0.134	0.073	0.549	86.1
		555	0.567	0.135	0.087	0.647	81.8
		570	0.582	0.137	0.085	0.621	75.2
		585	0.595	0.135	0.088	0.655	72.6
		600	0.607	0.133	0.093	0.699	74.4
		615	0.620	0.132	0.082	0.622	68.9
		630	0.637	0.130	0.081	0.618	70.3
		645	0.647	0.131	0.084	0.639	73.1
		660	0.659	0.134	0.082	0.614	73.6
		675	0.676	0.131	0.089	0.678	76.6
		705	0.700	0.130	0.091	0.700	68.9
		720	0.714	0.129	0.080	0.618	66.5

		735	0.726	0.126	0.077	0.608	67.3
		750	0.739	0.130	0.089	0.687	63.4
		765	0.755	0.135	0.083	0.614	76.9
		780	0.767	0.130	0.094	0.726	65.5
		795	0.779	0.136	0.091	0.667	76.9
		810					80.3
		840	0.820	0.135	0.081	0.596	72.6
		855	0.836	0.128	0.082	0.643	77.9
		870	0.849	0.125	0.084	0.666	77.9
		885					73.1
		900	0.876	0.125	0.080	0.638	71.5
		915	0.891	0.127	0.077	0.606	75.9
		930	0.905	0.129	0.075	0.583	69.6
		945	0.921	0.127	0.076	0.597	77.9
		960	0.938	0.132	0.081	0.616	65.5
		975	0.947	0.136	0.074	0.545	59.5
		1005	0.980	0.138	0.084	0.612	67.3
		1020	0.996	0.137	0.076	0.555	69.6
		1035	1.014	0.137	0.078	0.570	79.8
		1050	1.025	0.134	0.086	0.637	77.7
		1065	1.037	0.130	0.075	0.579	72.1
		1080	1.048	0.134	0.073	0.548	76.9

APPENDIX J:

Time variation in sediment yield (kg s^{-1}) for each experimental run.

Sediment Yield					
Run	Date	Time	Fluid Volume	Sediment Mass	Sediment Yield
(Initial headcut height)		(s)	(l)	(kg)	(kg s^{-1})
0.005(1)	11-Mar-1998	7	0.37118	0.00217	0.00678
		13	0.43651	0.00152	0.00403
		20	0.41483	0.00145	0.00407
		27	0.41737	0.00172	0.00477
		33	0.43109	0.00184	0.00495
		41	0.42801	0.00225	0.00608
		47	0.41834	0.00135	0.00374
		56	0.39765	0.00110	0.00322
		62	0.39963	0.00094	0.00272
		70	0.42089	0.00088	0.00244
		80	0.41796	0.00090	0.00249
		89	0.39299	0.00134	0.00396
		96	0.35472	0.00093	0.00304
		104	0.41225	0.00088	0.00247
		118	0.40851	0.00088	0.00250
		124	0.43646	0.00074	0.00197
		131	0.41630	0.00087	0.00242
		137	0.42545	0.00080	0.00217
		150	0.40911	0.00086	0.00245
		180	0.40293	0.00078	0.00225
		210	0.38579	0.00093	0.00279
		240	0.36375	0.00070	0.00224
		270	0.41773	0.00092	0.00257
		300	0.37819	0.00095	0.00291
		330	0.44888	0.00136	0.00350
		360	0.46418	0.00158	0.00396
		390	0.45301	0.00128	0.00326
		420	0.42698	0.00138	0.00375
		450	0.45347	0.00122	0.00313
		480	0.39355	0.00102	0.00301
		510	0.42114	0.00119	0.00328
		540	0.43081	0.00095	0.00257
		570	0.44159	0.00102	0.00268
		600	0.38635	0.00128	0.00383
		630	0.44337	0.00088	0.00230

		660	0.43998		
		690	0.45264	0.00098	0.00252
		720	0.43236	0.00102	0.00273
		750	0.43243	0.00108	0.00290
		780	0.43206	0.00123	0.00331
		810	0.39621	0.00113	0.00332
		870	0.36160	0.00189	0.00607
		900	0.37017	0.00116	0.00363
		930	0.39701	0.00135	0.00394
		960	0.44359	0.00050	0.00131
		990	0.38702	0.00149	0.00447
		1020	0.43911	0.00182	0.00481
		1050	0.40362	0.00141	0.00404
		1080	0.42195	0.00156	0.00428
		1110	0.39833	0.00175	0.00511
		1140	0.45261	0.00220	0.00564
		1170	0.42223	0.00126	0.00345
		1200	0.42179	0.00169	0.00466
		1230	0.40867	0.00186	0.00527
		1260	0.39445	0.00159	0.00468
		1290	0.44226	0.00204	0.00535
		1320	0.38428	0.00139	0.00420
		1350	0.39048	0.00131	0.00388
		1380	0.45546	0.00463	
		1410	0.44404	0.00165	0.00430
		1440	0.41086	0.00147	0.00414
		1470	0.43796	0.00144	0.00382
		1500	0.42010	0.00149	0.00411
		1530	0.41445	0.00190	0.00532
		1560	0.46299	0.00198	0.00496
		1590	0.43850	0.00251	0.00664
		1620	0.42689	0.00219	0.00594
		1650	0.31027	0.00126	0.00471
		1680	0.37846	0.00157	0.00483
		1710	0.27913	0.00480	
		1740	0.39287	0.00212	0.00625
		1770	0.44431	0.00204	0.00534
		1800	0.41088	0.00177	0.00501
		1830	0.27521	0.00149	0.00626
		1860	0.45411	0.00258	0.00660
		1890	0.38897	0.00178	0.00530
		1920	0.46372	0.00233	0.00583

		1950	0.46790	0.00201	0.00499
		1980	0.33853	0.00155	0.00530
		2030	0.40939	0.00228	0.00645
		2060	0.45540	0.00209	0.00532
		2090	0.37787	0.00178	0.00546
		2120	0.44856	0.00270	0.00699
		2150	0.43079	0.00293	0.00788
0.005(2)	27-Mar-1998	8	0.41605	0.00283	0.00794
		14	0.45189	0.00083	0.00215
		20	0.42174	0.00146	0.00403
		26	0.43426	0.00211	0.00567
		34	0.37404	0.00234	0.00730
		38	0.40157	0.00298	0.00866
		44	0.36280	0.00238	0.00767
		49	0.31894	0.00238	0.00870
		55	0.35691	0.00246	0.00805
		61	0.39372	0.00197	0.00583
		67	0.42856	0.00208	0.00567
		72	0.38100	0.00200	0.00614
		79	0.37384	0.00203	0.00635
		85	0.43780	0.00268	0.00714
		90	0.41020	0.00234	0.00665
		97	0.37022	0.00236	0.00745
		103	0.40106	0.00452	0.01317
		120	0.42003	0.00491	0.01366
		150	0.40132	0.00228	0.00662
		180	0.41065	0.00206	0.00587
		210	0.37248	0.00166	0.00519
		240	0.39749	0.00221	0.00649
		270	0.35041	0.00211	0.00702
		300	0.37288	0.01446	
		330	0.40738	0.00193	0.00554
		360	0.37421	0.00163	0.00509
		390	0.37793	0.00194	0.00599
		420	0.39518	0.00168	0.00497
		450	0.39657	0.00197	0.00581
		480	0.34957	0.00151	0.00504
		510	0.37661	0.00170	0.00529
		540	0.42583	0.00314	0.00862
		570	0.38483	0.00194	0.00588
		600	0.43730	0.00248	0.00661

		630	0.39660	0.00180	0.00530
		660	0.38965	0.00195	0.00585
		690	0.38571	0.00173	0.00524
		720	0.39966	0.00208	0.00607
		750	0.35826	0.00227	0.00738
		780	0.38606	0.00242	0.00732
		810	0.41353	0.00245	0.00692
		870	0.33007	0.00196	0.00694
		900	0.40335	0.00264	0.00765
		930	0.37518	0.00197	0.00613
		960	0.45036	0.00225	0.00584
		990	0.39164	0.00233	0.00695
		1020	0.37696	0.00236	0.00731
		1050	0.38878	0.00237	0.00710
		1080	0.34508	0.00221	0.00748
		1110	0.38649	0.00233	0.00704
		1170	0.38076	0.00238	0.00731
		1200	0.41557	0.00251	0.00705
		1230	0.33584	0.00253	0.00881
0.010	5-Mar-1998	7	0.43952	0.00301	
		13	0.43890	0.00115	0.00304
		19	0.42710	0.00191	0.00517
		25	0.41879	0.00218	0.00603
		31	0.42367	0.00250	0.00684
		37	0.41554	0.00307	0.00854
		43	0.42697	0.00376	0.01019
		49	0.41252	0.00338	0.00947
		55	0.42455	0.00468	0.01275
		61	0.40759	0.00430	0.01222
		67	0.42707	0.00535	0.01449
		73	0.41806	0.00491	0.01359
		79	0.40546	0.00498	0.01422
		86	0.43932	0.00554	0.01460
		97	0.42933	0.00542	0.01462
		103	0.42851	0.00597	0.01613
		110	0.43556	0.00552	0.01466
		117	0.43649	0.00619	0.01642
		121	0.44975	0.00559	0.01438
		129	0.45306	0.00570	0.01457
		136	0.44826	0.00518	0.01338
		142	0.42060	0.00493	0.01358

		149	0.42422	0.00500	0.01363
		157	0.44446	0.00500	0.01301
		180	0.40753	0.00434	0.01231
		210	0.42685	0.00402	0.01090
		240	0.42228	0.00402	0.01102
		270	0.41179	0.00351	0.00988
		300	0.40900	0.00331	0.00936
		330	0.43537	0.00353	0.00938
		360	0.43697	0.00284	0.00753
		390	0.44328	0.00337	0.00879
		420	0.43231	0.00271	0.00725
		450	0.43433	0.00326	0.00870
		480	0.43663	0.00322	0.00855
		510	0.44900	0.00311	0.00801
		540	0.44194	0.00340	0.00889
		570	0.44589	0.00349	0.00905
		600	0.44519	0.00336	0.00873
		630	0.42546	0.00279	0.00758
		660	0.42122	0.00278	0.00765
		690	0.42402	0.00307	0.00838
		720	0.39731	0.00265	0.00773
		750	0.43412	0.00234	0.00623
		780	0.44728	0.00264	0.00682
		810	0.42367	0.00254	0.00693
		840	0.42543	0.00255	0.00693
		870	0.42301	0.00279	0.00763
		900	0.42180	0.00255	0.00699
		930	0.42342	0.00289	0.00790
		960	0.40821	0.00296	0.00841
		990	0.43476	0.00299	0.00797
		1020	0.42004	0.00275	0.00757
		1050	0.38830	0.00243	0.00725
		1080	0.41618	0.00263	0.00733
		1110	0.42691	0.00279	0.00757
		1140	0.43229	0.00278	0.00745
		1170	0.42158	0.00302	0.00829
		1200	0.42045	0.00338	0.00930
		1230	0.43340	0.00320	0.00855
		1260	0.38994	0.00326	0.00967
0.015	20-Feb-1998	8	0.41477	0.00646	
		14	0.40718	0.00371	0.01061

		20	0.43423	0.00484	0.01296
		27	0.44179	0.00599	0.01576
		33	0.43221	0.00713	0.01920
		39	0.37162	0.00575	0.01801
		45	0.43182	0.00905	0.02438
		52	0.41941	0.00824	0.02285
		58	0.43436	0.00838	0.02245
		64	0.43713	0.00919	0.02445
		70	0.41509	0.00730	0.02044
		76	0.43145	0.00810	0.02182
		83	0.40727	0.00729	0.02083
		90	0.45137	0.00781	0.02012
		98	0.43002	0.00646	0.01748
		105	0.43524	0.00727	0.01942
		112	0.42319	0.00699	0.01921
		120	0.42920	0.00779	0.02111
		150	0.37782	0.00578	0.01778
		180	0.38887	0.00492	0.01471
		210	0.44640	0.00612	0.01593
		240	0.36894	0.00403	0.01272
		270	0.46808	0.00450	0.01119
		300	0.44843	0.00415	0.01078
		330	0.45005	0.00345	0.00892
		360	0.37795	0.00278	0.00855
		390	0.42888	0.00293	0.00794
		420	0.42575	0.00270	0.00739
		450	0.44970	0.00271	0.00702
		480	0.46717	0.00298	0.00742
		510	0.45306	0.00372	0.00955
		540	0.46996	0.00409	0.01013
		570	0.46854	0.00324	0.00804
		600	0.34673	0.00202	0.00679
		630	0.42122	0.00225	0.00622
		660	0.45859	0.00381	0.00967
		690	0.44624	0.00399	0.01040
		720	0.44597	0.00523	0.01364
		750	0.43686	0.00477	0.01270
		780	0.46000	0.00441	0.01116
		810	0.43929	0.00403	0.01066
		840	0.46671	0.00411	0.01024
		870	0.45104	0.00397	0.01023
		900	0.44711	0.00496	0.01289

		930	0.42588	0.00421	0.01150
		960	0.41548	0.00374	0.01048
		990	0.42345	0.00378	0.01038
		1020	0.43799	0.00413	0.01096
0.020	10-Feb-1998	5	0.46860	0.02294	
		10	0.44829	0.00805	0.02097
		16	0.31890	0.00558	0.02043
		21	0.31293	0.00505	0.01884
		27	0.42192	0.00811	0.02244
		32	0.46384	0.01129	0.02841
		37	0.47202	0.01117	0.02761
		42	0.44000	0.01003	0.02660
		47	0.45700	0.01075	0.02744
		52	0.43349	0.01019	0.02743
		57	0.42561	0.00932	0.02555
		63	0.36231	0.00810	0.02609
		68	0.40264	0.01038	0.03009
		74	0.44586	0.00892	0.02335
		85	0.42733	0.01035	0.02826
		120	0.44302	0.00882	0.02324
		150	0.44166	0.00748	0.01978
		180	0.44019	0.00611	0.01619
		210	0.45641	0.00564	0.01442
		240	0.42742	0.00497	0.01357
		270	0.45322	0.00417	0.01074
		300	0.42322	0.00383	0.01057
		330	0.45986	0.00362	0.00920
		360	0.43766	0.00409	0.01091
		390	0.38717	0.00299	0.00902
		420	0.45945	0.00394	0.01000
		450	0.41992	0.00345	0.00958
		480	0.44330	0.00340	0.00896
		510	0.40721	0.00328	0.00941
		540	0.44276	0.00443	0.01166
		570	0.44304	0.00345	0.00909
		600	0.43457	0.00276	0.00741
		630	0.41708	0.00334	0.00936
		660	0.44246	0.00334	0.00882
		690	0.35553	0.00246	0.00809
		720	0.44166	0.00264	0.00696
		750	0.39819	0.00309	0.00907

		780	0.42494	0.00254	0.00697
		810	0.44435	0.00296	0.00776
		840	0.43677	0.00341	0.00911
		870	0.40880	0.00320	0.00914
		900	0.46259	0.00415	0.01047
		930	0.39464	0.00347	0.01026
		960	0.45847	0.00424	0.01080
		990	0.44476	0.00345	0.00905
		1020	0.43828	0.00200	0.00533
		1050	0.46559	0.00301	0.00755
		1080	0.43127	0.00352	0.00952
		1110	0.44848	0.00460	0.01196
0.025	12-Dec-1997	4	0.43623	0.00884	0.02360
		10	0.34620	0.00314	0.01057
		16	0.41829	0.00412	0.01148
		22	0.42364	0.00514	0.01414
		27	0.48041	0.00858	0.02081
		33	0.46853	0.01093	0.02717
		39	0.47728	0.01473	0.03595
		45	0.36354	0.01175	0.03764
		50	0.47818	0.01667	0.04061
		56	0.47582	0.01463	0.03582
		61	0.47395	0.01526	0.03751
		67	0.46798	0.01435	0.03572
		74	0.47710	0.01367	0.03337
		82	0.43032	0.01031	0.02791
		88	0.42798	0.01109	0.03017
		95	0.45273	0.01274	0.03279
		102	0.47781	0.01287	0.03137
		120	0.48715	0.01213	0.02902
		150	0.43872	0.00852	0.02261
		180	0.46654	0.00848	0.02118
		210	0.40084	0.00621	0.01803
		240	0.49610	0.00737	0.01730
		270	0.48876	0.00765	0.01824
		300	0.47560	0.00675	0.01652
		330	0.48058	0.00673	0.01632
		360	0.47332	0.00610	0.01502
		390	0.47432	0.00615	0.01510
		420	0.48038	0.00656	0.01591
		450	0.46917	0.00592	0.01471

		480	0.44937	0.00548	0.01422
		510	0.43400	0.00519	0.01393
		540	0.49341	0.00609	0.01438
		570	0.48057	0.00614	0.01488
		600	0.48183	0.00579	0.01400
		630	0.46613	0.00584	0.01458
		660	0.43947	0.00571	0.01513
		690	0.45979	0.00573	0.01451
		720	0.48470	0.00819	0.01968
		750	0.48399	0.00700	0.01684
		780	0.45730	0.00540	0.01376
		810	0.48653	0.00594	0.01423
		840	0.45735	0.00633	0.01611
		870	0.49452	0.00664	0.01564
		900	0.48670	0.00632	0.01512
0.030(1)	19-Nov-1997	5	0.41065	0.01380	0.03925
		13	0.27628	0.00442	0.01867
		22	0.43563	0.01154	0.03092
		27	0.32605	0.00856	0.03066
		34	0.35504	0.01026	0.03375
		40	0.28238	0.01012	0.04183
		45	0.34540	0.01442	0.04875
		50	0.24051	0.00950	0.04615
		57	0.33799	0.01333	0.04608
		67	0.35459	0.01319	0.04345
		72	0.43128	0.01525	0.04129
		79	0.44892	0.01400	0.03642
		96	0.40642	0.01178	0.03386
		104	0.29364	0.00762	0.03031
		120	0.42300	0.00875	0.02416
		150	0.46943	0.01026	0.02553
		180	0.43327	0.00702	0.01893
		210	0.43473	0.00780	0.02096
		240	0.46412	0.00856	0.02153
		270	0.45894	0.00761	0.01938
		300	0.43115	0.00683	0.01851
		330	0.45263	0.00825	0.02130
		360	0.42355	0.00663	0.01827
		390	0.48022	0.00815	0.01982
		420	0.45226	0.00727	0.01878
		450	0.42497	0.00809	0.02223

		480	0.42700	0.00627	0.01716
		510	0.38976	0.00531	0.01593
		540	0.42665	0.00627	0.01717
		570	0.45157	0.00677	0.01751
		600	0.39981	0.00549	0.01602
		630	0.41244	0.00595	0.01686
		660	0.43363	0.00597	0.01608
		690	0.43373	0.00637	0.01715
		720	0.42115	0.00648	0.01797
0.030(2)	17-Mar-1998	7	0.42258	0.00562	0.01554
		13	0.42681	0.00520	0.01424
		20	0.42644	0.00611	0.01674
		27	0.42893	0.00846	0.02304
		34	0.43393	0.01231	0.03312
		41	0.43545	0.01615	0.04331
		47	0.34803	0.01245	0.04177
		54	0.35024	0.01956	0.06521
		61	0.42328	0.02251	0.06211
		68	0.34983	0.01637	0.05464
		75	0.37550	0.01550	0.04819
		81	0.42104	0.01584	0.04394
		88	0.42399	0.01515	0.04172
		96	0.44245	0.01519	0.04010
		104	0.42254	0.01338	0.03697
		111	0.43970	0.01399	0.03717
		118	0.41955	0.01388	0.03864
		150	0.39886	0.01219	0.03569
		180	0.39321	0.00809	0.02402
		210	0.39760	0.00833	0.02446
		240	0.38818	0.00678	0.02040
		270	0.33648	0.00669	0.02323
		300	0.38950	0.00665	0.01992
		330	0.41564	0.00695	0.01951
		360	0.39346	0.00630	0.01871
		390	0.36617	0.00620	0.01977
		420	0.35230	0.00598	0.01984
		450	0.40026	0.00686	0.02002
		480	0.40597	0.00801	0.02305
		510	0.45231	0.00941	0.02429
		540	0.37091	0.01244	
		570	0.43740	0.01162	

		600	0.39966	0.00902	0.02635
		630	0.44045	0.00833	0.02210
		660	0.45249	0.00837	0.02159
0.035	1-Dec-1997	6	0.43806	0.00812	0.02156
		12	0.36252	0.00571	0.01833
		18	0.43516	0.00858	0.02295
		23	0.38178	0.01001	0.03051
		29	0.39656	0.01265	0.03711
		34	0.41258	0.01779	0.05017
		39	0.43896	0.01003	0.02658
		45	0.44640	0.01581	0.04123
		52	0.43174	0.01643	0.04429
		57	0.46834	0.01538	0.03822
		64	0.41715	0.01415	0.03947
		71	0.39373	0.01438	0.04250
		77	0.42605	0.00771	0.02107
		87	0.44122	0.01404	0.03703
		95	0.42413	0.01321	0.03625
		102	0.41848	0.01092	0.03037
		109	0.43887	0.01291	0.03424
		120	0.42661	0.00970	0.02645
		150	0.38633	0.00956	0.02879
		180	0.39429	0.00682	0.02012
		210	0.44230	0.00840	0.02211
		240	0.39299	0.00676	0.02000
		270	0.30280		
		300	0.43965	0.00637	0.01685
		330	0.43916	0.00663	0.01757
		360	0.44132	0.00696	0.01835
		390	0.43499	0.00677	0.01811
		420	0.44566	0.00726	0.01896
		450	0.44460	0.00659	0.01724
		480	0.45133	0.00663	0.01710
		510	0.44241	0.00674	0.01773
		540	0.45103	0.00691	0.01782
		570	0.38171	0.00525	0.01599
		600	0.44725	0.00637	0.01658
		630	0.42745	0.00497	0.01353
		660	0.46256	-0.00089	
		690	0.45443	0.00492	0.01260
		720	0.47360	0.00555	0.01363

		750	0.43722	0.00536	0.01426
		780	0.42733	0.00530	0.01443
		810	0.47008	0.00628	0.01554
		840	0.43066	0.00536	0.01448
		870	0.45661	0.00644	0.01642
0.040	4-Feb-1998	5	0.42943	0.01093	0.02977
		11	0.46699	0.00383	0.00960
		16	0.37600	0.00806	0.02508
		22	0.41320	0.01061	0.03005
		28	0.41537	0.01090	0.03071
		35	0.39441	0.01434	0.04253
		41	0.44004	0.01821	0.04841
		46	0.45244	0.02189	0.05660
		51	0.46850	0.02119	0.05291
		55	0.38479	0.01831	0.05566
		60	0.44967	0.02095	0.05451
		65	0.37274	0.01576	0.04945
		70	0.36326	0.01339	0.04313
		77	0.39553	0.01405	0.04156
		83	0.41180	0.01418	0.04029
		120	0.46006	0.01200	0.03051
		150	0.44610	0.01201	0.03149
		180	0.45658	0.00956	0.02450
		210	0.44331	0.00872	0.02302
		240	0.41304	0.00717	0.02031
		270	0.42304	0.00829	0.02292
		300	0.46886	0.00910	0.02270
		330	0.45634	0.00826	0.02118
		360	0.42901	0.00704	0.01920
		390	0.44711	0.00863	0.02259
		420	0.40393	0.00786	0.02275
		450	0.41937	0.00764	0.02132
		480	0.45490	0.00797	0.02051
		510	0.45022	0.00823	0.02139
		540	0.48710	0.00812	0.01950
		570	0.41273	0.00688	0.01950
		600	0.39338	0.00679	0.02019
		630	0.40759	0.00623	0.01787
		660	0.47343	0.00722	0.01784
		690	0.46756	0.00732	0.01831
		720	0.45105	0.00690	0.01790

		750	0.40602	0.00595	0.01715
		780	0.40984	0.00612	0.01746
		810	0.37897	0.00551	0.01700
		840	0.39645	0.00684	0.02018
0.045	17-Feb-1998	6	0.44131	0.02543	
		12	0.46251	0.01808	0.04554
		17	0.38606	0.01321	0.03986
		21	0.39788	0.01880	0.05506
		27	0.44899	0.02645	0.06864
		34	0.41554	0.02675	0.07501
		39	0.44091	0.02494	0.06591
		44	0.44117	0.02571	0.06789
		50	0.42869	0.02260	0.06143
		56	0.40646	0.02277	0.06527
		61	0.40469	0.01948	0.05609
		68	0.36456	0.01623	0.05186
		74	0.40140	0.01686	0.04893
		81	0.42967	0.01721	0.04667
		88	0.45452	0.01690	0.04332
		120	0.40723	0.01318	0.03772
		150	0.38060	0.01125	0.03443
		180	0.44593	0.01226	0.03204
		210	0.46383	0.01281	0.03218
		240	0.44565	0.01086	0.02838
		270	0.44965	0.01039	0.02692
		300	0.41650	0.00929	0.02599
		330	0.40782	0.00830	0.02371
		360	0.43920	0.00919	0.02437
		390	0.44009	0.00873	0.02312
		420	0.43426	0.00930	0.02494
		450	0.35472	0.00717	0.02354
		480	0.44464	0.00969	0.02539
		510	0.42861	0.00832	0.02261
		540	0.39655	0.00753	0.02213
		570	0.43396	0.00811	0.02177
		600	0.43551	0.00848	0.02268
		630	0.41373	0.00847	0.02386
		660	0.45050	0.00929	0.02402
0.050(1)	26-Feb-1998	9	0.43806	0.00597	0.01587
		14	0.37541	0.01078	0.03346

		20	0.38248	0.01584	0.04824
		26	0.42467	0.02461	0.06751
		32	0.44059	0.02470	0.06533
		38	0.36355	0.02159	0.06920
		44	0.39699	0.02363	0.06936
		51	0.44061	0.02253	0.05959
		58	0.40968	0.02395	0.06812
		64	0.43611	0.02085	0.05570
		69	0.42263	0.02138	0.05894
		76	0.44096	0.02379	0.06286
		82	0.42689	0.02057	0.05614
		120	0.44199	0.01451	0.03826
		150	0.40728	0.01241	0.03551
		180	0.43574	0.01247	0.03335
		210	0.43688	0.01200	0.03201
		240	0.45217	0.01130	0.02912
		270	0.39930	0.00918	0.02679
		300	0.41830	0.00882	0.02458
		330	0.42079	0.00957	0.02649
		360	0.30288	0.00820	0.03155
		390	0.41342	0.01043	0.02940
		420	0.45997	0.01079	0.02733
		450	0.43823	0.01004	0.02669
		480	0.46333	0.01058	0.02660
		510	0.45817	0.01009	0.02565
		540	0.45440	0.00951	0.02440
		570	0.34998	0.00716	0.02382
		600	0.45224	0.00913	0.02352
		630	0.45645	0.01067	0.02725
		660	0.43139	0.00968	0.02616
		690	0.43215	0.01100	0.02967
		720	0.43241	0.01073	0.02892
		750	0.43092	0.01032	0.02791
		780	0.41140	0.01018	0.02883
		810	0.43137	0.00987	0.02666
0.050(2)	23-Mar-1998	6	0.42144	0.01911	
		12	0.37611	0.00733	0.02275
		19	0.36392	0.01057	0.03391
		26	0.43073	0.01311	0.03553
		33	0.35788	0.01969	0.06426
		40	0.40228	0.02226	0.06462

		47	0.38618	0.02296	0.06942
		53	0.42447	0.02026	0.05573
		60	0.40922	0.01777	0.05073
		66	0.42672	0.02288	0.06262
		72	0.41330	0.02154	0.06086
		78	0.40322	0.01949	0.05645
		84	0.40571	0.01683	0.04845
		91	0.36819	0.01396	0.04427
		97	0.41765	0.01474	0.04122
		120	0.36235	0.01401	0.04515
		150	0.38527	0.01186	0.03594
		180	0.39068	0.01003	0.02998
		210	0.38149	0.00803	0.02457
		240	0.34119	0.00895	0.03063
		270	0.40883	0.00794	0.02269
		300	0.41439	0.01035	0.02918
		330	0.39589	0.00665	0.01961
		360	0.43495	0.00677	0.01819
		390	0.37654	0.00625	0.01938
		420	0.36166	0.00706	0.02280
		450	0.44991	0.00708	0.01839
		480	0.38739	0.00981	0.02958
		510	0.40548	0.00598	0.01723
		540	0.42043	0.00760	0.02110
		570	0.42431	0.00799	0.02198
		600	0.47281	0.00784	0.01937
		630	0.42157	0.00803	0.02224
		660	0.42136	0.00776	0.02150
		690	0.37675	0.00737	0.02286
		720	0.38323	0.00719	0.02193
		750	0.41983	0.00766	0.02131
		780	0.36998	0.00649	0.02049
		810	0.39048	0.00761	0.02276
		840	0.45668	0.01085	0.02773
		870	0.42620	0.00948	0.02598
		900	0.40235	0.00877	0.02547
		930	0.38719	0.00791	0.02387
		960	0.37914	0.00709	0.02185
		990	0.41741	0.00784	0.02194
		1020	0.41584	0.00852	0.02392
		1050	0.41452	0.00856	0.02412
		1080	0.41565	0.00777	0.02183

APPENDIX K:

Along-flume profiles of the initial bed surfaces, the final bed surface, and the trace of the scour hole for each experimental run.

Bed Profiles					
Run	Date	Position	Initial Bed	Final Bed	Scour Trace
(Initial headcut height)			Profile	Profile	
		(m)	(m)	(m)	(m)
0.005(1)	11-Mar-1998	0.00	0.00000	0.00000	
		0.01	-0.00010	0.00020	
		0.02	-0.00020	0.00041	
		0.03	-0.00030	-0.00060	
		0.04	-0.00040	0.00021	
		0.05	-0.00050	0.00041	
		0.06	-0.00060	0.00031	
		0.07	-0.00070	0.00021	
		0.08	-0.00080	0.00103	
		0.09	-0.00090	0.00062	
		0.10	-0.00100	0.00083	
		0.11	-0.00110	0.00134	
		0.12	-0.00120	0.00002	
		0.13	-0.00130	0.00053	
		0.14	-0.00140	0.00134	
		0.15	-0.00150	0.00033	
		0.16	-0.00160	0.00145	
		0.17	-0.00170	0.00104	
		0.18	-0.00180	0.00064	
		0.19	-0.00190	0.00084	
		0.20	-0.00200	0.00105	
		0.21	-0.00210	-0.00027	
		0.22	-0.00220	-0.00007	
		0.23	-0.00230	-0.00078	
		0.24	-0.00240	0.00034	
		0.25	-0.00250	-0.00037	
		0.26	-0.00260	-0.00138	
		0.27	-0.00270	0.00035	
		0.28	-0.00280	-0.00067	
		0.29	-0.00290	-0.00016	
		0.30	-0.00300	-0.00117	
		0.31	-0.00310	-0.00127	
		0.32	-0.00320	-0.00107	
		0.33	-0.00330	-0.00147	

		0.34	-0.00340	-0.00157	
		0.35	-0.00350	-0.00198	
		0.36	-0.00360	-0.00177	
		0.37	-0.00370	-0.00888	
		0.38	-0.00380	-0.01325	
		0.39	-0.00390	-0.01731	
		0.40	-0.00400	-0.02412	
		0.41	-0.00410	-0.03062	
		0.42	-0.00420	-0.03651	
		0.43	-0.00430	-0.04270	
		0.44	-0.00440	-0.04829	
		0.45	-0.00450	-0.05205	-0.05205
		0.46	-0.00460	-0.05458	-0.05458
		0.47	-0.00470	-0.05712	-0.06012
		0.48	-0.00480	-0.05936	-0.06436
		0.49	-0.00490	-0.05854	-0.06554
		0.50	-0.00500	-0.05864	-0.06764
		0.51	-0.00510	-0.05783	-0.06683
		0.52	-0.00520	-0.05610	-0.06810
		0.53	-0.00530	-0.05346	-0.06646
		0.54	-0.00540	-0.05173	-0.06473
		0.55	-0.00550	-0.04908	-0.06308
		0.56	-0.00560	-0.04553	-0.06153
		0.57	-0.00570	-0.04258	-0.05858
		0.58	-0.00580	-0.04116	-0.05816
		0.59	-0.00590	-0.03851	-0.06051
		0.60	-0.00600	-0.03800	-0.06300
		0.61	-0.00610	-0.03932	-0.06732
		0.62	-0.00620	-0.03851	-0.07151
		0.63	-0.00630	-0.03617	-0.07217
		0.64	-0.00640	-0.03535	-0.07435
		0.65	-0.00650	-0.03302	-0.06902
		0.66	-0.00660	-0.02915	-0.06315
		0.67	-0.00670	-0.02712	-0.06312
		0.68	-0.00680	-0.02387	-0.06087
		0.69	-0.00690	-0.02244	-0.06244
		0.70	-0.00700	-0.02224	-0.06124
		0.71	-0.00710	-0.02051	-0.06251
		0.72	-0.00720	-0.02031	-0.06331
		0.73	-0.00730	-0.01980	-0.06280
		0.74	-0.00740	-0.01898	-0.06198
		0.75	-0.00750	-0.01908	-0.06208

		0.76	-0.00760	-0.01735	-0.05935
		0.77	-0.00770	-0.01745	-0.06045
		0.78	-0.00780	-0.01755	-0.06055
		0.79	-0.00790	-0.01796	-0.06196
		0.80	-0.00800	-0.01775	-0.06075
		0.81	-0.00810	-0.01755	-0.06055
		0.82	-0.00820	-0.01795	-0.06095
		0.83	-0.00830	-0.01836	-0.06136
		0.84	-0.00840	-0.01785	-0.06085
		0.85	-0.00850	-0.01795	-0.05995
		0.86	-0.00860	-0.01774	-0.05774
		0.87	-0.00870	-0.01784	-0.05484
		0.88	-0.00880	-0.01764	-0.05364
		0.89	-0.00890	-0.01743	-0.05243
		0.90	-0.00900	-0.01753	-0.05253
		0.91	-0.00910	-0.01641	-0.04941
		0.92	-0.00920	-0.01682	-0.04882
		0.93	-0.00930	-0.01661	-0.04661
		0.94	-0.00940	-0.01641	-0.04641
		0.95	-0.00950	-0.01621	-0.04621
		0.96	-0.00960	-0.01631	-0.04531
		0.97	-0.00970	-0.01671	-0.04571
		0.98	-0.00980	-0.01681	-0.04681
		0.99	-0.00990	-0.01996	-0.05596
		1.00	-0.01000	-0.02372	-0.06072
		1.01	-0.01010	-0.02503	-0.06203
		1.02	-0.01020	-0.02483	-0.06083
		1.03	-0.01030	-0.02341	-0.05641
		1.04	-0.01040	-0.02381	-0.05481
		1.05	-0.01050	-0.02422	-0.05422
		1.06	-0.01060	-0.02563	-0.05163
		1.07	-0.01070	-0.02502	-0.04702
		1.08	-0.01080	-0.02543	-0.04543
		1.09	-0.01090	-0.02583	-0.04583
		1.10	-0.01100	-0.02593	-0.04593
		1.11	-0.01110	-0.02573	-0.04173
		1.12	-0.01120	-0.02613	-0.04213
		1.13	-0.01130	-0.02562	-0.04162
		1.14	-0.01140	-0.02572	-0.04072
		1.15	-0.01150	-0.02552	-0.04052
		1.16	-0.01160	-0.02501	-0.04001
		1.17	-0.01170	-0.02420	-0.03920

		1.18	-0.01180	-0.02186	-0.03586
		1.19	-0.01190	-0.02104	-0.03604
		1.20	-0.01200	-0.01931	-0.03431
		1.21	-0.01210	-0.01850	-0.03350
		1.22	-0.01220	-0.01738	-0.03238
		1.23	-0.01230	-0.01718	-0.03418
		1.24	-0.01240	-0.01667	-0.03367
		1.25	-0.01250	-0.01555	-0.03255
		1.26	-0.01260	-0.01443	-0.03443
		1.27	-0.01270	-0.01300	-0.03400
		1.28	-0.01280	-0.01280	-0.03380
		1.29	-0.01290	-0.01229	-0.03129
		1.30	-0.01300	-0.01300	-0.02900
		1.31	-0.01310	-0.01310	-0.02810
		1.32	-0.01320	-0.01259	-0.02759
		1.33	-0.01330	-0.01330	-0.02930
		1.34	-0.01340	-0.01401	-0.03101
		1.35	-0.01350	-0.01411	-0.03211
		1.36	-0.01360	-0.01360	-0.02860
		1.37	-0.01370	-0.01614	-0.03314
		1.38	-0.01380	-0.01685	-0.03285
		1.39	-0.01390	-0.01786	-0.03486
		1.40	-0.01400	-0.01827	-0.03427
		1.41	-0.01410	-0.01928	-0.03328
		1.42	-0.01420	-0.01908	-0.03208
		1.43	-0.01430	-0.02009	-0.03309
		1.44	-0.01440	-0.02171	-0.03571
		1.45	-0.01450	-0.02212	-0.03412
		1.46	-0.01460	-0.02161	-0.03361
		1.47	-0.01470	-0.02262	-0.03462
		1.48	-0.01480	-0.02242	-0.03342
		1.49	-0.01490	-0.02191	-0.03391
		1.50	-0.01500	-0.02201	-0.03401
		1.51	-0.01510	-0.02241	-0.03441
		1.52	-0.02020	-0.02221	-0.03421
		1.53	-0.02030	-0.02201	-0.03401
		1.54	-0.02040	-0.02180	-0.03380
		1.55	-0.02050	-0.02221	-0.03721
		1.56	-0.02060	-0.02231	-0.03631
		1.57	-0.02070	-0.02271	-0.03571
		1.58	-0.02080	-0.02251	-0.03451
		1.59	-0.02090	-0.02261	-0.03461

		1.60	-0.02100	-0.02210	-0.03310
		1.61	-0.02110	-0.02220	-0.03220
		1.62	-0.02120	-0.02199	-0.03099
		1.63	-0.02130	-0.02209	-0.03009
		1.64	-0.02140	-0.02189	-0.02889
		1.65	-0.02150	-0.02168	-0.02768
		1.66	-0.02160	-0.02148	-0.02548
		1.67	-0.02170	-0.02188	-0.02388
		1.68	-0.02180	-0.02198	-0.02398
		1.69	-0.02190	-0.02239	-0.02339
		1.70	-0.02200	-0.02218	-0.02318
		1.71	-0.02210	-0.02259	-0.02359
		1.72	-0.02220	-0.02177	-0.02277
		1.73	-0.02230	-0.02218	-0.02318
		1.74	-0.02240	-0.02136	-0.02336
		1.75	-0.02250	-0.02177	-0.02377
		1.76	-0.02260	-0.02187	-0.02387
		1.77	-0.02270	-0.02227	-0.02427
		1.78	-0.02280	-0.02268	-0.02468
		1.79	-0.02290	-0.02247	-0.02447
		1.80	-0.02300	-0.02288	-0.02488
		1.81	-0.02310	-0.02267	-0.02467
		1.82	-0.02320	-0.02308	-0.02608
		1.83	-0.02330	-0.02257	-0.02657
		1.84	-0.02340	-0.02267	-0.02767
		1.85	-0.02350	-0.02246	-0.02546
		1.86	-0.02360	-0.02287	-0.02587
		1.87	-0.02370	-0.02297	-0.02497
		1.88	-0.02380	-0.02307	-0.02507
		1.89	-0.02390	-0.02378	-0.02478
		1.90	-0.02400	-0.02357	-0.02457
		1.91	-0.02410	-0.02337	-0.02437
		1.92	-0.02420	-0.02408	-0.02508
		1.93	-0.02430	-0.02357	
		1.94	-0.02440	-0.02367	
		1.95	-0.02450	-0.02346	
		1.96	-0.02460	-0.02387	
		1.97	-0.02470	-0.02458	
		1.98	-0.02480	-0.02468	
		1.99	-0.02490	-0.02539	
		2.00	-0.02500	-0.02518	
		2.01	-0.02510	-0.02467	

		2.02	-0.02520	-0.02477	
		2.03	-0.02530	-0.02396	
0.005(2)	27-Mar-1998	0.00	0.00000	0.00000	
		0.01	-0.00010	0.00203	
		0.02	-0.00020	0.00224	
		0.03	-0.00030	0.00122	
		0.04	-0.00040	-0.00070	
		0.05	-0.00050	-0.00294	
		0.06	-0.00060	-0.00212	
		0.07	-0.00070	-0.00131	
		0.08	-0.00080	-0.00019	
		0.09	-0.00090	0.00184	
		0.10	-0.00100	0.00205	
		0.11	-0.00110	0.00256	
		0.12	-0.00120	0.00276	
		0.13	-0.00130	0.00236	
		0.14	-0.00140	0.00226	
		0.15	-0.00150	0.00185	
		0.16	-0.00160	0.00236	
		0.17	-0.00170	0.00104	
		0.18	-0.00180	0.00125	
		0.19	-0.00190	0.00206	
		0.20	-0.00200	0.00227	
		0.21	-0.00210	0.00217	
		0.22	-0.00220	0.00146	
		0.23	-0.00230	0.00166	
		0.24	-0.00240	0.00187	
		0.25	-0.00250	0.00177	
		0.26	-0.00260	0.00289	
		0.27	-0.00270	0.00279	
		0.28	-0.00280	0.00238	
		0.29	-0.00290	0.00259	
		0.30	-0.00300	0.00279	
		0.31	-0.00310	0.00269	
		0.32	-0.00320	-0.00381	
		0.33	-0.00330	-0.00635	
		0.34	-0.00340	-0.00950	
		0.35	-0.00350	-0.01417	
		0.36	-0.00360	-0.01914	
		0.37	-0.00370	-0.02503	
		0.38	-0.00380	-0.02757	

		0.39	-0.00390	-0.03011	
		0.40	-0.00400	-0.03478	
		0.41	-0.00410	-0.03763	
		0.42	-0.00420	-0.03956	-0.03956
		0.43	-0.00430	-0.03752	-0.03752
		0.44	-0.00440	-0.03732	-0.03832
		0.45	-0.00450	-0.03742	-0.03842
		0.46	-0.00460	-0.03813	-0.04113
		0.47	-0.00470	-0.03792	-0.04092
		0.48	-0.00480	-0.03863	-0.04363
		0.49	-0.00490	-0.03660	-0.04060
		0.50	-0.00500	-0.03578	-0.04078
		0.51	-0.00510	-0.03375	-0.04075
		0.52	-0.00520	-0.03050	-0.04150
		0.53	-0.00530	-0.02633	-0.04033
		0.54	-0.00540	-0.02216	-0.04416
		0.55	-0.00550	-0.02013	-0.04313
		0.56	-0.00560	-0.01901	-0.04401
		0.57	-0.00570	-0.01820	-0.04620
		0.58	-0.00580	-0.01769	-0.04069
		0.59	-0.00590	-0.01809	-0.04209
		0.60	-0.00600	-0.01667	-0.04867
		0.61	-0.00610	-0.01555	-0.05055
		0.62	-0.00620	-0.01504	-0.04904
		0.63	-0.00630	-0.01392	-0.04692
		0.64	-0.00640	-0.01371	-0.04471
		0.65	-0.00650	-0.01412	-0.05112
		0.66	-0.00660	-0.01513	-0.05213
		0.67	-0.00670	-0.01523	-0.05223
		0.68	-0.00680	-0.01533	-0.05333
		0.69	-0.00690	-0.01482	-0.05182
		0.70	-0.00700	-0.01462	-0.05162
		0.71	-0.00710	-0.01441	-0.05241
		0.72	-0.00720	-0.01391	-0.05191
		0.73	-0.00730	-0.01370	-0.05370
		0.74	-0.00740	-0.01380	-0.05380
		0.75	-0.00750	-0.01329	-0.05329
		0.76	-0.00760	-0.01339	-0.05339
		0.77	-0.00770	-0.01380	-0.05380
		0.78	-0.00780	-0.01451	-0.05551
		0.79	-0.00790	-0.01461	-0.05461
		0.80	-0.00800	-0.01440	-0.05440

		0.81	-0.00810	-0.01541	-0.05441
		0.82	-0.00820	-0.01582	-0.05582
		0.83	-0.00830	-0.01592	-0.05492
		0.84	-0.00840	-0.01541	-0.05441
		0.85	-0.00850	-0.01490	-0.05290
		0.86	-0.00860	-0.01439	-0.05339
		0.87	-0.00870	-0.01449	-0.05449
		0.88	-0.00880	-0.01490	-0.05190
		0.89	-0.00890	-0.01621	-0.05121
		0.90	-0.00900	-0.01692	-0.05292
		0.91	-0.00910	-0.01581	-0.05181
		0.92	-0.00920	-0.01560	-0.04960
		0.93	-0.00930	-0.01540	-0.04740
		0.94	-0.00940	-0.01519	-0.04919
		0.95	-0.00950	-0.01346	-0.04646
		0.96	-0.00960	-0.01783	-0.04883
		0.97	-0.00970	-0.01762	-0.04662
		0.98	-0.00980	-0.01711	-0.04511
		0.99	-0.00990	-0.01661	-0.04561
		1.00	-0.01000	-0.01671	-0.04571
		1.01	-0.01010	-0.01650	-0.04550
		1.02	-0.01020	-0.01538	-0.04538
		1.03	-0.01030	-0.01548	-0.04648
		1.04	-0.01040	-0.01650	-0.04950
		1.05	-0.01050	-0.01599	-0.04799
		1.06	-0.01060	-0.01517	-0.04417
		1.07	-0.01070	-0.01558	-0.04358
		1.08	-0.01080	-0.01568	-0.04168
		1.09	-0.01090	-0.01578	-0.04378
		1.10	-0.01100	-0.01618	-0.04618
		1.11	-0.01110	-0.01598	-0.04698
		1.12	-0.01120	-0.01669	-0.04869
		1.13	-0.01130	-0.01587	-0.04887
		1.14	-0.01140	-0.01567	-0.04967
		1.15	-0.01150	-0.01638	-0.04638
		1.16	-0.01160	-0.01587	-0.04487
		1.17	-0.01170	-0.01597	-0.04497
		1.18	-0.01180	-0.01607	-0.04607
		1.19	-0.01190	-0.01617	-0.04717
		1.20	-0.01200	-0.01627	-0.04627
		1.21	-0.01210	-0.01637	-0.04637
		1.22	-0.01220	-0.01555	-0.04455

		1.23	-0.01230	-0.01626	-0.04426
		1.24	-0.01240	-0.01758	-0.04758
		1.25	-0.01250	-0.01738	-0.04838
		1.26	-0.01260	-0.01778	-0.04878
		1.27	-0.01270	-0.01788	-0.04988
		1.28	-0.01280	-0.01798	-0.04798
		1.29	-0.01290	-0.01778	-0.04778
		1.30	-0.01300	-0.01818	-0.04718
		1.31	-0.01310	-0.01889	-0.04789
		1.32	-0.01320	-0.01899	-0.04699
		1.33	-0.01330	-0.01879	-0.04679
		1.34	-0.01340	-0.01889	-0.04689
		1.35	-0.01350	-0.01868	-0.04768
		1.36	-0.01360	-0.01939	-0.04739
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		1.38	-0.01380	-0.01959	-0.04359
		1.39	-0.01390	-0.01908	-0.04208
		1.40	-0.01400	-0.01918	-0.04018
		1.41	-0.01410	-0.01928	-0.03928
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		1.44	-0.01440	-0.01867	-0.03167
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		1.55	-0.02050	-0.01916	-0.02416
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		1.62	-0.02120	-0.02016	-0.02416
		1.63	-0.02130	-0.02057	-0.02457
		1.64	-0.02140	-0.01975	-0.02375

		1.65	-0.02150	-0.02016	-0.02416
		1.66	-0.02160	-0.02117	-0.02517
		1.67	-0.02170	-0.02127	-0.02527
		1.68	-0.02180	-0.02107	-0.02507
		1.69	-0.02190	-0.02086	-0.02486
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		1.71	-0.02210	-0.02076	-0.02476
		1.72	-0.02220	-0.02025	-0.02425
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		1.88	-0.02380	-0.01910	-0.02110
		1.89	-0.02390	-0.02012	-0.02112
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		1.93	-0.02430	-0.01900	
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		0.10	-0.00100	0.00022	
		0.11	-0.00110	0.00012	
		0.12	-0.00120	0.00002	
		0.13	-0.00130	0.00022	
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		0.22	-0.00220	-0.00068	
		0.23	-0.00230	-0.00017	
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		0.36	-0.00360	-0.03530	
		0.37	-0.00370	-0.04027	
		0.38	-0.00380	-0.04982	
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		0.40	-0.00400	-0.06008	
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		0.47	-0.00470	-0.06870	-0.06870
		0.48	-0.00480	-0.06698	-0.06698
		0.49	-0.00490	-0.06555	-0.06555
		0.50	-0.00500	-0.06352	-0.06352
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		0.54	-0.00540	-0.04716	-0.05516
		0.55	-0.00550	-0.04207	-0.05307
		0.56	-0.00560	-0.03760	-0.05360
		0.57	-0.00570	-0.03374	-0.05374
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		0.59	-0.00590	-0.02937	-0.05137
		0.60	-0.00600	-0.02673	-0.04373
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		0.79	-0.00790	-0.01643	-0.06243
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		0.88	-0.00880	-0.01855	-0.06755
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		0.10	-0.00100	0.00144	
		0.11	-0.00110	0.00073	
		0.12	-0.00120	0.00124	
		0.13	-0.00130	0.00053	
		0.14	-0.00140	0.00134	
		0.15	-0.00150	0.00002	
		0.16	-0.00160	0.00053	
		0.17	-0.00170	0.00226	
		0.18	-0.00180	0.00094	
		0.19	-0.00190	0.00084	
		0.20	-0.00200	0.00074	
		0.21	-0.00210	0.00064	
		0.22	-0.00220	0.00024	
		0.23	-0.00230	-0.00078	
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		0.32	-0.00320	0.00046	
		0.33	-0.00330	0.00005	
		0.34	-0.00340	-0.00066	
		0.35	-0.00350	-0.00045	
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		0.38	-0.00380	-0.00197	
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		0.48	-0.00480	-0.00267	

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		0.75	-0.00750	-0.08004	-0.09204
		0.76	-0.00760	-0.07801	-0.09601
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		1.49	-0.01490	-0.03105	-0.06605
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		1.59	-0.03590	-0.03510	-0.06610
		1.60	-0.03600	-0.03459	-0.06359
		1.61	-0.03610	-0.03561	-0.06161
		1.62	-0.03620	-0.03479	-0.05479
		1.63	-0.03630	-0.03459	-0.04859
		1.64	-0.03640	-0.03591	-0.04791
		1.65	-0.03650	-0.03631	-0.04731
		1.66	-0.03660	-0.03489	-0.04689
		1.67	-0.03670	-0.03590	-0.04790
		1.68	-0.03680	-0.03692	-0.04892
		1.69	-0.03690	-0.03610	-0.05010
		1.70	-0.03700	-0.03529	-0.05129
		1.71	-0.03710	-0.03691	-0.04991
		1.72	-0.03720	-0.03518	-0.04818
		1.73	-0.03730	-0.03498	-0.04798
		1.74	-0.03740	-0.03477	-0.04677
		1.75	-0.03750	-0.03487	-0.04687
		1.76	-0.03760	-0.03528	-0.04728
		1.77	-0.03770	-0.03477	-0.04277
		1.78	-0.03780	-0.03548	-0.04348
		1.79	-0.03790	-0.03466	-0.04166

		1.80	-0.03800	-0.03415	-0.04115
		1.81	-0.03810	-0.03608	-0.04308
		1.82	-0.03820	-0.03466	-0.04166
		1.83	-0.03830	-0.03384	-0.04184
		1.84	-0.03840	-0.03425	-0.04125
		1.85	-0.03850	-0.03404	-0.03904
		1.86	-0.03860	-0.03506	-0.04206
		1.87	-0.03870	-0.03485	-0.03985
		1.88	-0.03880	-0.03526	-0.03826
		1.89	-0.03890	-0.03536	-0.03536
		1.90	-0.03900	-0.03546	-0.03546
		1.91	-0.03910	-0.03586	-0.03586
		1.92	-0.03920	-0.03627	-0.03627
		1.93	-0.03930	-0.03637	-0.03637
		1.94	-0.03940	-0.03677	
		1.95	-0.03950	-0.03657	
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		0.04	-0.00040	-0.00101	
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		0.07	-0.00070	-0.00040	
		0.08	-0.00080	-0.00050	
		0.09	-0.00090	-0.00029	
		0.10	-0.00100	0.00052	
		0.11	-0.00110	0.00134	
		0.12	-0.00120	0.00002	
		0.13	-0.00130	0.00083	
		0.14	-0.00140	0.00165	
		0.15	-0.00150	0.00002	
		0.16	-0.00160	0.00145	

		0.17	-0.00170	0.00074	
		0.18	-0.00180	0.00094	
		0.19	-0.00190	0.00054	
		0.20	-0.00200	0.00044	
		0.21	-0.00210	0.00064	
		0.22	-0.00220	0.00054	
		0.23	-0.00230	0.00044	
		0.24	-0.00240	0.00034	
		0.25	-0.00250	0.00024	
		0.26	-0.00260	0.00014	
		0.27	-0.00270	0.00035	
		0.28	-0.00280	0.00025	
		0.29	-0.00290	0.00076	
		0.30	-0.00300	-0.00056	
		0.31	-0.00310	-0.00036	
		0.32	-0.00320	-0.00046	
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		0.34	-0.00340	-0.00066	
		0.35	-0.00350	-0.00015	
		0.36	-0.00360	-0.00055	
		0.37	-0.00370	-0.00157	
		0.38	-0.00380	-0.00136	
		0.39	-0.00390	-0.00146	
		0.40	-0.00400	-0.00187	
		0.41	-0.00410	-0.00197	
		0.42	-0.00420	-0.00176	
		0.43	-0.00430	-0.00186	
		0.44	-0.00440	-0.00196	
		0.45	-0.00450	-0.00541	
		0.46	-0.00460	-0.01892	
		0.47	-0.00470	-0.02725	
		0.48	-0.00480	-0.03589	
		0.49	-0.00490	-0.04940	
		0.50	-0.00500	-0.07693	
		0.51	-0.00510	-0.08434	
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		0.54	-0.00540	-0.10354	
		0.55	-0.00550	-0.10547	-0.10547
		0.56	-0.00560	-0.10435	-0.11235
		0.57	-0.00570	-0.10232	-0.11232
		0.58	-0.00580	-0.09998	-0.11498

		0.59	-0.00590	-0.09581	-0.12381
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		0.64	-0.00640	-0.06614	-0.11514
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		0.66	-0.00660	-0.05689	-0.11189
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		0.69	-0.00690	-0.04317	-0.10517
		0.70	-0.00700	-0.04083	-0.11083
		0.71	-0.00710	-0.03880	-0.10780
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		0.73	-0.00730	-0.03656	-0.09756
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		0.75	-0.00750	-0.03463	-0.09763
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		0.81	-0.00810	-0.03157	-0.09957
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		0.85	-0.00850	-0.03105	-0.09905
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		0.92	-0.00920	-0.03175	-0.09675
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		1.02	-0.01020	-0.03458	-0.10158
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		1.04	-0.01040	-0.03478	-0.09978
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		1.16	-0.01160	-0.03842	-0.11142
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		1.18	-0.01180	-0.03893	-0.11093
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		0.51	-0.00510	-0.08861	
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		1.11	-0.01110	-0.04371	-0.11871
		1.12	-0.01120	-0.04381	-0.11781
		1.13	-0.01130	-0.04361	-0.11761
		1.14	-0.01140	-0.04401	-0.12001
		1.15	-0.01150	-0.04442	-0.12042
		1.16	-0.01160	-0.04452	-0.12052
		1.17	-0.01170	-0.04431	-0.11931
		1.18	-0.01180	-0.04441	-0.12041
		1.19	-0.01190	-0.04451	-0.12051
		1.20	-0.01200	-0.04461	-0.12061
		1.21	-0.01210	-0.04502	-0.12002
		1.22	-0.01220	-0.04512	-0.11912
		1.23	-0.01230	-0.04552	-0.11952
		1.24	-0.01240	-0.04562	-0.11862
		1.25	-0.01250	-0.04572	-0.11772
		1.26	-0.01260	-0.04613	-0.11813
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		1.28	-0.01280	-0.04633	-0.11833
		1.29	-0.01290	-0.04643	-0.11743
		1.30	-0.01300	-0.04653	-0.11853
		1.31	-0.01310	-0.04693	-0.11893
		1.32	-0.01320	-0.04734	-0.11734
		1.33	-0.01330	-0.04591	-0.11491
		1.34	-0.01340	-0.04632	-0.11432
		1.35	-0.01350	-0.04703	-0.11503
		1.36	-0.01360	-0.04682	-0.11282
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		1.44	-0.01440	-0.04671	-0.10471
		1.45	-0.01450	-0.04620	-0.10420
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		1.47	-0.01470	-0.04579	-0.10579

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		1.56	-0.04560	-0.04669	-0.08969
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		1.70	-0.04700	-0.04504	
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		0.60	-0.00600	-0.10231	-0.10231
		0.61	-0.00610	-0.10759	-0.10759
		0.62	-0.00620	-0.11257	-0.11257
		0.63	-0.00630	-0.11724	-0.11724
		0.64	-0.00640	-0.11826	-0.11826
		0.65	-0.00650	-0.12018	-0.12018
		0.66	-0.00660	-0.12059	-0.12159
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		0.68	-0.00680	-0.10799	-0.11599
		0.69	-0.00690	-0.10291	-0.12091
		0.70	-0.00700	-0.09386	-0.11486
		0.71	-0.00710	-0.08878	-0.11678
		0.72	-0.00720	-0.08340	-0.11540
		0.73	-0.00730	-0.07923	-0.11723

		0.74	-0.00740	-0.07415	-0.11515
		0.75	-0.00750	-0.06907	-0.12007
		0.76	-0.00760	-0.06429	-0.11829
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		0.78	-0.00780	-0.05413	-0.12013
		0.79	-0.00790	-0.05087	-0.11987
		0.80	-0.00800	-0.04915	-0.12115
		0.81	-0.00810	-0.04650	-0.12250
		0.82	-0.00820	-0.04599	-0.12399
		0.83	-0.00830	-0.04366	-0.12266
		0.84	-0.00840	-0.04315	-0.12115
		0.85	-0.00850	-0.04233	-0.12433
		0.86	-0.00860	-0.04121	-0.12121
		0.87	-0.00870	-0.04040	-0.12240
		0.88	-0.00880	-0.03989	-0.12389
		0.89	-0.00890	-0.03877	-0.12177
		0.90	-0.00900	-0.04009	-0.12209
		0.91	-0.00910	-0.03958	-0.12158
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		0.06	-0.00060	-0.00090	
		0.07	-0.00070	-0.00161	
		0.08	-0.00080	0.00011	
		0.09	-0.00090	0.00062	
		0.10	-0.00100	0.00052	
		0.11	-0.00110	0.00012	
		0.12	-0.00120	0.00032	
		0.13	-0.00130	0.00053	
		0.14	-0.00140	0.00012	
		0.15	-0.00150	0.00033	
		0.16	-0.00160	0.00023	
		0.17	-0.00170	0.00074	
		0.18	-0.00180	0.00033	
		0.19	-0.00190	0.00023	
		0.20	-0.00200	-0.00017	
		0.21	-0.00210	-0.00088	
		0.22	-0.00220	0.00024	
		0.23	-0.00230	0.00075	
		0.24	-0.00240	-0.00057	
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		0.30	-0.00300	-0.00178	
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		0.32	-0.00320	-0.00137	
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		0.34	-0.00340	-0.00157	
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		0.36	-0.00360	-0.00208	
		0.37	-0.00370	-0.00248	
		0.38	-0.00380	-0.00380	
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		0.40	-0.00400	-0.00248	
		0.41	-0.00410	-0.00258	

		0.42	-0.00420	-0.00268	
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		0.46	-0.00460	-0.08019	
		0.47	-0.00470	-0.08577	
		0.48	-0.00480	-0.09227	
		0.49	-0.00490	-0.09786	
		0.50	-0.00500	-0.10345	
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		0.52	-0.00520	-0.10578	
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		0.65	-0.00650	-0.07050	-0.11250
		0.66	-0.00660	-0.06481	-0.10481
		0.67	-0.00670	-0.06156	-0.10456
		0.68	-0.00680	-0.05648	-0.10148
		0.69	-0.00690	-0.05353	-0.09353
		0.70	-0.00700	-0.05119	-0.10019
		0.71	-0.00710	-0.04886	-0.09986
		0.72	-0.00720	-0.04804	-0.10104
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		0.89	-0.00890	-0.04426	-0.10126
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		1.12	-0.01120	-0.05296	-0.11896
		1.13	-0.01130	-0.05367	-0.11767
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		1.54	-0.06540	-0.06478	-0.08378
		1.55	-0.06550	-0.06518	-0.07718
		1.56	-0.06560	-0.06528	-0.08028
		1.57	-0.06570	-0.06538	-0.06538
		1.58	-0.06580	-0.06548	-0.06548
		1.59	-0.06590	-0.06497	-0.06497
		1.60	-0.06600	-0.06416	-0.06416
		1.61	-0.06610	-0.06426	-0.06426
		1.62	-0.06620	-0.06405	-0.06405
		1.63	-0.06630	-0.06385	-0.06385
		1.64	-0.06640	-0.06364	-0.06364
		1.65	-0.06650	-0.06374	
		1.66	-0.06660	-0.06384	
		1.67	-0.06670	-0.06394	
		1.68	-0.06680	-0.06343	
		1.69	-0.06690	-0.06353	
		1.70	-0.06700	-0.06333	
		1.71	-0.06710	-0.06282	
		1.72	-0.06720	-0.06444	

		1.73	-0.06730	-0.06424	
		1.74	-0.06740	-0.06373	
		1.75	-0.06750	-0.06291	
		1.76	-0.06760	-0.06362	
		1.77	-0.06770	-0.06281	
		1.78	-0.06780	-0.06321	
		1.79	-0.06790	-0.06392	
		1.80	-0.06800	-0.06402	
		1.81	-0.06810	-0.06473	
		1.82	-0.06820	-0.06514	
		1.83	-0.06830	-0.06432	
		1.84	-0.06840	-0.06503	
		1.85	-0.06850	-0.06605	
		1.86	-0.06860	-0.06523	
		1.87	-0.06870	-0.06564	
		1.88	-0.06880	-0.06574	
		1.89	-0.06890	-0.06553	
		1.90	-0.06900	-0.06533	
		1.91	-0.06910	-0.06604	
		1.92	-0.06920	-0.06644	
		1.93	-0.06930	-0.06654	
		1.94	-0.06940	-0.06695	
		1.95	-0.06950	-0.06735	
		1.96	-0.06960	-0.06745	
		1.97	-0.06970	-0.06786	
		1.98	-0.06980	-0.06796	
		1.99	-0.06990	-0.06867	
		2.00	-0.07000	-0.06907	
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		0.12	-0.00120	-0.00486	
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		0.14	-0.00140	-0.00231	
		0.15	-0.00150	-0.00059	
		0.16	-0.00160	0.00023	
		0.17	-0.00170	0.00135	
		0.18	-0.00180	0.00094	
		0.19	-0.00190	0.00206	
		0.20	-0.00200	0.00379	
		0.21	-0.00210	0.00339	
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		0.23	-0.00230	0.00166	
		0.24	-0.00240	0.00217	
		0.25	-0.00250	0.00177	
		0.26	-0.00260	0.00228	
		0.27	-0.00270	0.00248	
		0.28	-0.00280	0.00086	
		0.29	-0.00290	0.00167	
		0.30	-0.00300	0.00157	
		0.31	-0.00310	0.00086	
		0.32	-0.00320	0.00076	
		0.33	-0.00330	0.00036	
		0.34	-0.00340	-0.00005	
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		0.36	-0.00360	0.00006	
		0.37	-0.00370	-0.00035	
		0.38	-0.00380	-0.00075	
		0.39	-0.00390	-0.00085	
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		0.42	-0.00420	0.00037	
		0.43	-0.00430	-0.00186	
		0.44	-0.00440	-0.03061	
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		0.46	-0.00460	-0.04940	
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		0.48	-0.00480	-0.08862	-0.08862
		0.49	-0.00490	-0.09542	-0.09542
		0.50	-0.00500	-0.10253	-0.10553
		0.51	-0.00510	-0.10842	-0.11442

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		0.53	-0.00530	-0.11990	-0.12690
		0.54	-0.00540	-0.12457	-0.13257
		0.55	-0.00550	-0.12680	-0.13580
		0.56	-0.00560	-0.12904	-0.13904
		0.57	-0.00570	-0.13097	-0.14197
		0.58	-0.00580	-0.13229	-0.14729
		0.59	-0.00590	-0.13208	-0.15108
		0.60	-0.00600	-0.12974	-0.15574
		0.61	-0.00610	-0.12375	-0.15575
		0.62	-0.00620	-0.12049	-0.15749
		0.63	-0.00630	-0.11724	-0.15924
		0.64	-0.00640	-0.11216	-0.15416
		0.65	-0.00650	-0.10677	-0.15277
		0.66	-0.00660	-0.10108	-0.15008
		0.67	-0.00670	-0.09448	-0.14748
		0.68	-0.00680	-0.08940	-0.14540
		0.69	-0.00690	-0.08432	-0.13932
		0.70	-0.00700	-0.07954	-0.13654
		0.71	-0.00710	-0.07598	-0.13698
		0.72	-0.00720	-0.07212	-0.13512
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		0.74	-0.00740	-0.06531	-0.12931
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		0.76	-0.00760	-0.06094	-0.12594
		0.77	-0.00770	-0.05860	-0.12460
		0.78	-0.00780	-0.05718	-0.12718
		0.79	-0.00790	-0.05636	-0.13136
		0.80	-0.00800	-0.05555	-0.13255
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		0.84	-0.00840	-0.05473	-0.13073
		0.85	-0.00850	-0.05452	-0.12952
		0.86	-0.00860	-0.05462	-0.13062
		0.87	-0.00870	-0.05533	-0.12933
		0.88	-0.00880	-0.05513	-0.12813
		0.89	-0.00890	-0.05492	-0.12792
		0.90	-0.00900	-0.05502	-0.12802
		0.91	-0.00910	-0.05573	-0.12773
		0.92	-0.00920	-0.05583	-0.12683
		0.93	-0.00930	-0.05593	-0.12693

		0.94	-0.00940	-0.05695	-0.12895
		0.95	-0.00950	-0.05735	-0.13135
		0.96	-0.00960	-0.05776	-0.13276
		0.97	-0.00970	-0.05816	-0.13016
		0.98	-0.00980	-0.05826	-0.12926
		0.99	-0.00990	-0.05836	-0.13136
		1.00	-0.01000	-0.05938	-0.13238
		1.01	-0.01010	-0.06008	-0.13608
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		1.06	-0.01060	-0.06241	-0.14241
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		1.09	-0.01090	-0.06302	-0.14302
		1.10	-0.01100	-0.06312	-0.14512
		1.11	-0.01110	-0.06383	-0.14583
		1.12	-0.01120	-0.06454	-0.14654
		1.13	-0.01130	-0.06464	-0.14664
		1.14	-0.01140	-0.06474	-0.14474
		1.15	-0.01150	-0.06392	-0.14492
		1.16	-0.01160	-0.06463	-0.14963
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		1.18	-0.01180	-0.06422	-0.14922
		1.19	-0.01190	-0.06524	-0.14824
		1.20	-0.01200	-0.06534	-0.14634
		1.21	-0.01210	-0.06544	-0.14844
		1.22	-0.01220	-0.06508	-0.14708
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		1.24	-0.01240	-0.06574	-0.14874
		1.25	-0.01250	-0.06584	-0.14884
		1.26	-0.01260	-0.06594	-0.14894
		1.27	-0.01270	-0.06634	-0.15034
		1.28	-0.01280	-0.06614	-0.14614
		1.29	-0.01290	-0.06624	-0.14724
		1.30	-0.01300	-0.06634	-0.14634
		1.31	-0.01310	-0.06644	-0.14344
		1.32	-0.01320	-0.06654	-0.14454
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		1.34	-0.01340	-0.06765	-0.14965
		1.35	-0.01350	-0.06684	-0.14984

		1.36	-0.01360	-0.06724	-0.14824
		1.37	-0.01370	-0.06704	-0.14704
		1.38	-0.01380	-0.06744	-0.14644
		1.39	-0.01390	-0.06754	-0.14654
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		1.45	-0.01450	-0.06784	-0.13884
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		1.48	-0.01480	-0.06722	-0.12722
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		1.50	-0.01500	-0.06712	-0.12312
		1.51	-0.01510	-0.06752	-0.12052
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		1.57	-0.06570	-0.06721	-0.10121
		1.58	-0.06580	-0.06761	-0.09961
		1.59	-0.06590	-0.06680	-0.08980
		1.60	-0.06600	-0.06751	-0.08351
		1.61	-0.06610	-0.06669	-0.07569
		1.62	-0.06620	-0.06710	-0.07210
		1.63	-0.06630	-0.06720	-0.07020
		1.64	-0.06640	-0.06760	-0.06860
		1.65	-0.06650	-0.06740	-0.06740
		1.66	-0.06660	-0.06750	
		1.67	-0.06670	-0.06760	
		1.68	-0.06680	-0.06739	
		1.69	-0.06690	-0.06810	
		1.70	-0.06700	-0.06759	
		1.71	-0.06710	-0.06769	
		1.72	-0.06720	-0.06779	
		1.73	-0.06730	-0.06881	
		1.74	-0.06740	-0.06799	
		1.75	-0.06750	-0.06840	
		1.76	-0.06760	-0.06789	
		1.77	-0.06770	-0.06860	

		1.78	-0.06780	-0.06870	
		1.79	-0.06790	-0.06849	
		1.80	-0.06800	-0.06829	
		1.81	-0.06810	-0.06961	
		1.82	-0.06820	-0.06879	
		1.83	-0.06830	-0.06889	
		1.84	-0.06840	-0.06991	
		1.85	-0.06850	-0.06909	
		1.86	-0.06860	-0.07011	
		1.87	-0.06870	-0.06990	
		1.88	-0.06880	-0.07000	
		1.89	-0.06890	-0.07041	
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		1.91	-0.06910	-0.07061	
		1.92	-0.06920	-0.07071	
		1.93	-0.06930	-0.07111	
		1.94	-0.06940	-0.07121	
		1.95	-0.06950	-0.07131	
		1.96	-0.06960	-0.07141	
		1.97	-0.06970	-0.07243	
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		2.00	-0.07000	-0.07334	
		2.01	-0.07010	-0.07313	
		2.02	-0.07020	-0.07323	
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